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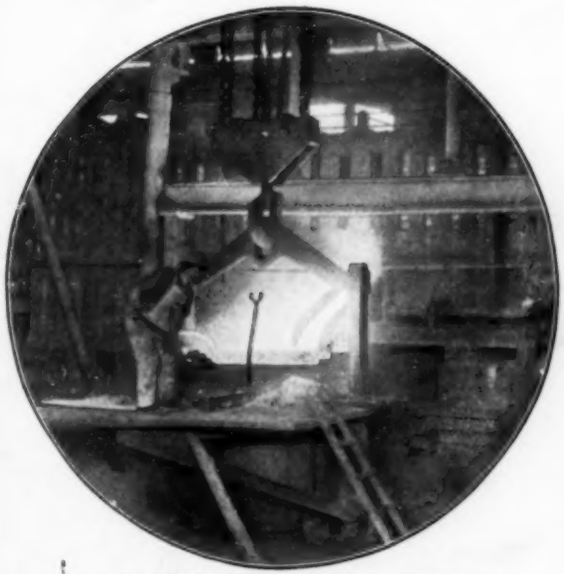

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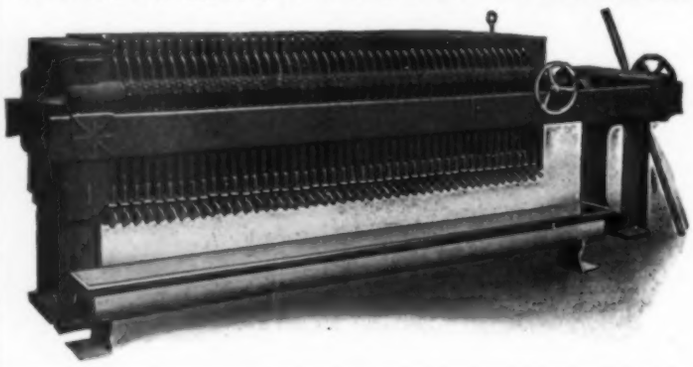

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METALLURGICAL & CHEMICAL ENGINEERING

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Presentation of the Perkin Medal to James Gayley 71
The Perkin medal is awarded annually for a noteworthy achievement in applied chemistry by a committee constituted of representatives of the different chemical societies of this country. This year it was awarded to Dr. James Gayley for his dry-blast process. An account of the presentation of the medal to Dr. Gayley on the evening of January 24th is given. Dr. Gayley's address on the history of the dry-blast process is printed in full.

Utilization of Wood Waste. By **Dr. John E. Teeple** 75
This is the second of a series of articles on the new industry of utilization of wood waste which is rapidly increasing in importance. Dr. Teeple is recognized as one of the highest authorities on this subject. The present instalment gives a classification of the raw materials of the industry.

Ore Sampling Without Machinery. By **Jesse Scobey** 83
A series of very interesting photographs which illustrate in a most instructive and simple manner the essential features which must be considered in ore sampling without machinery. Emphasis is laid on the utmost importance which correct sampling has on the conclusion to be drawn later on from the chemical analysis.

Recent Advances in the Spray Process for the Production of Metallic Coatings. By **M. U. Schoop** .. 89
The author reviews the evolution of a new process invented by him several years ago by which any kind of surface may receive a metallic coating, the metal being sprayed on it either in powdered or molten form. The latest design of apparatus suitable for this process is described.

The Technical Analysis of Ferro-Vanadium and Its Products. By **Wm. W. Clark** 91
This is the first of a series of articles by the Chief Chemist of the American Vanadium Company on the best methods for the technical analysis of ferro-vanadium. The present article deals with the determination of aluminium in ferro-vanadium.

Organization. By **T. C. Roberts** 95
An outline of the essentials of organization from engineering practice. The author is the chief engineer of the United Verde Copper Company, in Jerome, Ariz. Two interesting organization charts illustrate two different methods of organization.

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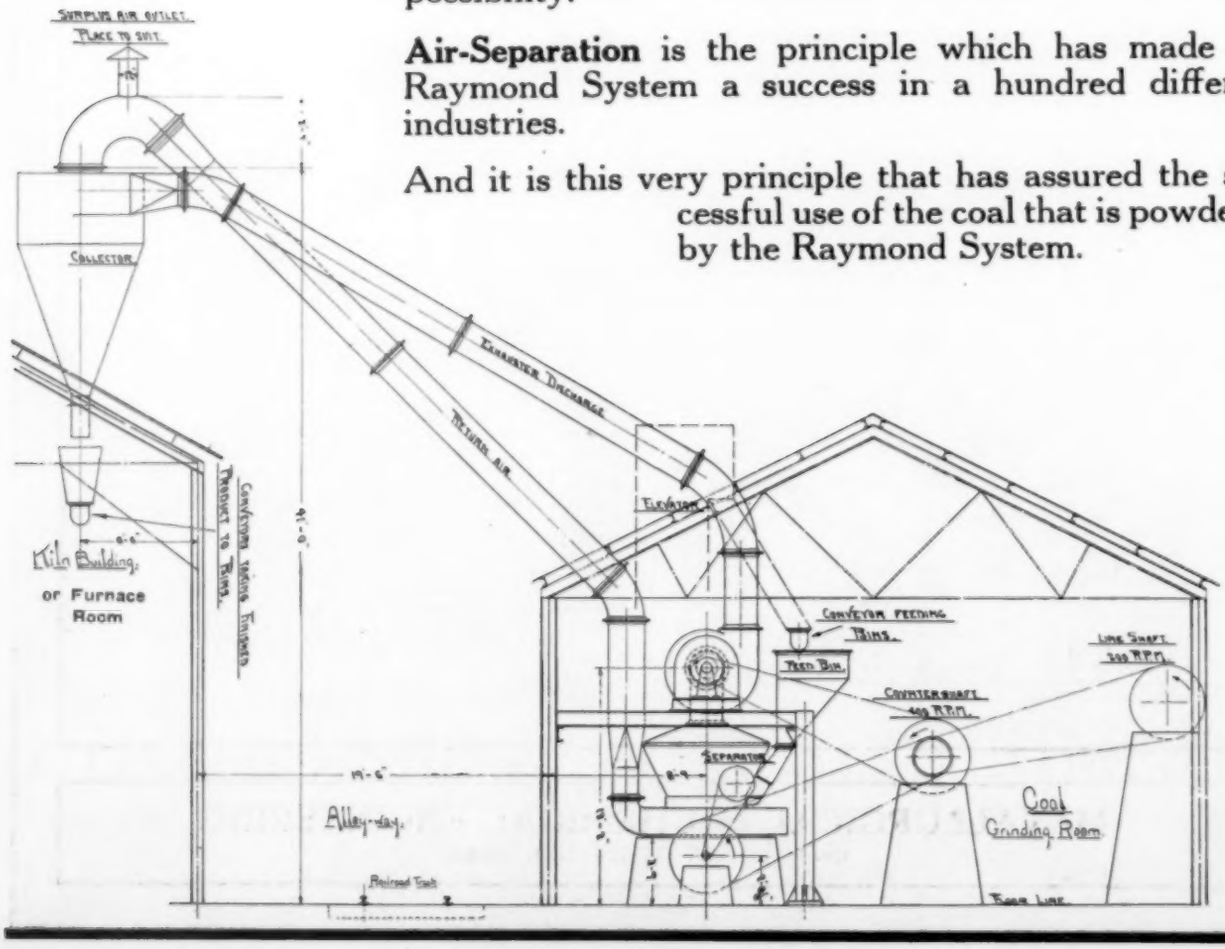

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Chemists as Captains of Industry

Elsewhere in this issue we print a report of the presentation of the seventh impression of the Perkin medal to Dr. James Gayley at a joint meeting of the national chemical societies of this country, held under the auspices of the Society of Chemical Industry on January 29.

The award of the Perkin medal to one who has highly distinguished himself in applied chemistry, has now become a delightful annual event in chemical society and club life. The Perkin medal has become an inspiration to all who have at heart the future of American chemistry, and the Perkin medal has become an education for the general public as to the scope and achievements of chemistry.

Let other countries be proud of their warriors, poets, and musicians, the United States is proud of its great captains of industry, and the Perkin medal has become a means of proclaiming to all the world how many of the great captains of industry have been recruited from chemistry. Here is a list of those who have received so far the Perkin medal: Sir William Perkin, the inventor of the dyestuff mauve and founder of the coal-tar industry; Dr. J. B. Francis Herreshoff, to whom the general chemical industry of this country and electrolytic copper refining owes so much; Dr. Arno Behr, of the great American industry of corn products; Dr. E. G. Acheson, the founder of the carborundum and artificial graphite industries; Dr. Chas. M. Hall, the founder of the American aluminium industry; Mr. Herman Frasch, of oil refining and sulphur mining fame, and now, Dr. James Gayley, the inventor of the dry-blast process, who began as a simple steel chemist and grew to be the first vice-president of the U. S. Steel Corporation.

This is certainly a brilliant list of names and a brilliant list of achievements. And yet, lest we forget, that is only the beginning.

Empirical vs. Exact Methods

It has been remarked that the oldest mining districts are the most conservative, where progress and change are accomplished only by laborious effort on the part of outsiders. In such places it is not uncommon to find metallurgical operations based on empirical knowledge derived from limited observation. The natives rely with satisfaction on tradition and custom, and rest contentedly on the use of inexact and unscientific methods without realizing their limitations. It is true that some empirical methods have a basis in fact and, in the hands of skilled operators and observers, serve a useful purpose. The control of the bessemerizing and poling of copper, and the estimation of the value of some gold-ores, are notable examples of arbitrary methods which, to the practiced eye, yield reliable results.

The vanning shovel is a device in the same class with the gold-pan. For years the practice of vanning has been

firmly entrenched in Cornwall as a method for determining the value of tin-ore and concentrate. The skill of the Cornishman with this device is proverbial. So great has been the reliance placed in the results obtained by the vanning shovel that the efficiency of milling operations and the buying and selling of concentrates are confidently based thereon, to the general exclusion of chemical methods of analysis.

There has been a growing suspicion that the vanning assay for tin is unreliable, together with a lack of confidence in the supposed efficiency of Cornish tin-milling when based on such assays. More recently this suspicion has been confirmed, and a rude shock given to the advocates of Cornish practice by one who has had an opportunity of studying the district and its methods. Fortified by the more exact methods of chemical analysis, this investigator has come to the conclusion that the vanning experts have been deceiving themselves as well as others; and that, so far from making a mill recovery of 90 per cent, the actual tin extraction throughout Cornwall to-day is between 50 per cent and 60 per cent. In competitive tests between the vanning assay and chemical analysis, the results of the former ranged from 22 per cent to 95 per cent of the latter, being more exact on high-grade coarse cassiterite.

In the light of these figures it seems almost incredible that a great industry should be controlled by such inexact methods; and more so that the custom should prevail in the face of better knowledge. The continuation of the practice in spite of the protests of those who are informed as to its deficiencies, shows how firmly rooted it is. Progressive metallurgists realize that the continued use of the vanning shovel is largely responsible for the backward condition of tin metallurgy in Cornwall, and they look for improvement in the latter as fast as accurate chemical analysis supersedes the arbitrary and inexact vanning assay.

Surface Quality in Steel

We have long been accustomed to think of quality in steel almost wholly in terms of elastic limit, yield point, ductility, hardness, resistance to fatigue, etc., while more lately we have had to consider, for certain classes of steel, magnetic permeability, hysteresis, conductivity, etc., and for certain other classes of steel the question of corrodibility has been emphasized by some producers.

A somewhat new factor has been looming large of late, on account of the extremely rapid increase in the use of steel sheets for metal furniture and for various automobile parts, particularly bodies and hoods. These sheets are required to take a high degree of finish. Various finishes are furnished by the sheet mills, leaving the surface in condition to take such coating as the fabricator desires to apply. It has been found that these so-called "finishes" given by the mill are not to be regarded purely as treatment superficial or entirely subsequent to the manufacture of the steel sheet. The character of the steel itself is found to have much to do with success in applying the "finishes." There is practically no literature on the subject.

The mills which have developed these finishes most successfully have not taken the public into their confidence. They have been learning rapidly, and the information has not had time to percolate, but it has become perfectly clear that to our researches as to how to make steel strong, ductile or hard as the case may be, qualities which are purely of cross section, there must be added study as to how to make steel such that it will present, or yield itself to being given, a particular character of surface. This is practically a new field in the adaptation of steel to commercial use. The first man who modified the character of steel in order to contribute to surface finish has not come forward to claim the honor, preferring to endeavor to maintain a commercial secret, but we have reason to believe that what he did was done only very recently.

Technical Education

University extension courses of study have developed a successful means of disseminating knowledge on many subjects. Short courses in agriculture have proved valuable for farmers, being given during the winter months when work on the farm is not pressing. Correspondence courses in a variety of subjects have served a useful end. Reasoning by analogy, it has been suggested that "practical" short courses in mining and milling, given by professional schools of mines, might be beneficial in raising the standard of work in those industries. The proposal raises a question on which there is a wide difference of opinion.

Recently the University of Tennessee has announced extension courses, designed especially for workers in mining and quarrying. Physics, chemistry, mathematics, geology, mining, metallurgy and mechanical engineering are the subjects touched upon during a short course of six weeks duration, supplemented by correspondence work. The object of the course is to afford an opportunity to the man "on the firing line" to improve his work by the understanding of scientific principles. Another school, at Platteville, Wisconsin, has for its aim the training of young men in the practical details of mine and mill work, without pretending to turn out finished engineers. This training school produces technicians, but not technologists.

The principal argument in favor of the short course is that it renders a distinct service and ultimately raises the standard of work. There are, perhaps, stronger arguments against the short course in professional mining schools. Alumni almost a unit against the plan, believing that it would detract from the reputation of the school, and affect their prestige as graduates. The difficulty arises of differentiating for the public between engineering graduates and short-course students. Each might, with varying degrees of propriety, claim attendance at a well-known school; but without further explanation, the short-course student would give the inference that he was on a par with the engineering graduate. Even if such a result were not intentional, it is a possibility.

Except for instances in which local conditions seem to favor the short course, it would seem better to maintain the integrity of the school of technology, and leave the other field for the strictly training school.

The Digest of U. S. Electrochemical Patents

When this journal was started somewhat over ten years ago with the title "Electrochemical Industry," analyses of current electrochemical U. S. Patents naturally suggested

themselves as valuable, instructive, and interesting news matter. At the same time it was obvious that for anybody who wants to look up the patents on a certain subject, it would be very important to be able to find also the older U. S. patents which had been issued before this journal was started. This consideration suggested a new department—one decidedly unique in technical journalism—the "Digest of Electrochemical U. S. Patents prior to 1903, arranged according to subject matters and in chronological order."

For the preparation of this department this journal had the good fortune to secure the services of one most competent to do the work—Dr. Eugene A. Byrnes. And the Digest, prepared by Dr. Byrnes, has been published regularly ever since. It has been used extensively by those who understand its scope and object. But the fact that the subscription list of this journal has increased very rapidly in recent years far beyond the limits of the original constituency, suggests that to many of our more recent friends the idea of the Digest may not be sufficiently familiar and to them a concise summary of the immense amount of work of love stored up in this department in the past ten years should be welcome. This also gives us an opportunity to say a word on electrochemical U. S. patents in general.

When Dr. Byrnes was appointed principal examiner of Division 3, "Metallurgy," etc., in April, 1891, the comparatively few U. S. patents theretofore granted relating to electrochemical subjects were scattered through several different divisions and subclasses of the Patent Office, especially through Division 3 with classes on metallurgy, coating with metals, and distillation; Division 6 with classes on bleaching and dyeing, chemicals, hides and leather, and medicines; Division 25 with a class on paper making (bleaching); Division 26 with subclasses on batteries for the generation of electricity.

As the art of electrochemistry was then becoming quite active, it seemed desirable to collect these scattered patents into a single class, and Dr. Byrnes suggested to the Commisisoner of Patents that such class be established under the title "Electrochemistry." Some argument was necessary to convince the Commissioner as to the need for this class, and the propriety of such title. However, in view of favorable recommendations of other examiners, and the fact that the word "electrochemistry" had been used to a slight extent by others, having been adopted by Becquerel as the title of his classic book, while the first edition of Borchers' "Elektro-Metallurgie" had just appeared, the Commissioner ordered the establishment of the new class, in May, 1892. The 390 patents which Dr. Byrnes had collected for this class were distributed into 27 subclasses, being, with two exceptions, those of the present classification.

On December 27, 1892, subclass 28, Diaphragms, was established, and the patents on batteries were received from Division 26, where they existed as subclass 6, "Batteries, Galvanic" and 72, Batteries, Secondary." On November 23, 1894, subclass 31, "Synthesis" and 32, "Synthesis, Ozone" were established, the old subclass 23, "Ozone," being abolished. The subclass of "Galvanic Batteries" was split up, prior to January 1, 1895, into subclasses 33-53, first published in the Official Gazette of that date. On January 31, 1897, new battery subclasses, 53-56, were established; also the following: 57—Refining Metals; 58—Chemicals, Alkalies and chlorine; 59—Chemicals, Bleaching and disinfecting liquors; 60—Chemicals, Chlorates; 61—Chemicals, Dyes and pigments; 62—Synthesis, carbides; 63—Reduction; 64—Electric furnaces; the old subclass 2, "Bleaching" being abolished. There has been no subsequent change in the classification of these patents.

At the date when Dr. Byrnes began to analyze these patents for the Digest in this journal, July 1, 1902, ten years after the class had been established, the number of electrochemical patents, aside from those on batteries, had increased from 390 to 1486; and on December 10, 1912, the number had increased to 3498.

The Digest, so far published, has covered the more important patents prior to 1903 according to subject matters in chronological order as follows:

Electrolysis of sodium chloride with mercury enthodes (vol. I, p. 42, 78).

Diaphragm cells for the production of caustic alkali (vol. I, p. 114, 152, 196, 232, 268, 300, 340).

Bleaching and disinfecting liquids (vol. I, p. 368, 401, 433).

White lead by electrolytic methods (vol. I, p. 474, 518).

Dyes and Pigments (vol. I, p. 518, 555).

Chemicals (vol. I, p. 598; vol. II, p. 43, 80, 123).

Production of aluminium from molten electrolytes (vol. II, p. 165, 210, 253).

Production of sodium from molten electrolytes (vol. II, p. 296, 333, 384, 434).

Molten electrolytes, Miscellaneous (vol. II, p. 434, 474, 517; vol. III, p. 48, 88).

Electric Smelting and Reduction Furnaces (vol. III, p. 128, 164, 208, 246, 284, 322, 362, 406, 448).

Treatment of carbon and the production of graphite (vol. III, p. 482; vol. IV, p. 42).

Production of nitrogen compounds (vol. IV, p. 80, 120).

Production of ozone and miscellaneous gas reactions (vol. IV, p. 162, 204, 252, 290, 338, 423, 468, 514).

Carborundum (vol. V, p. 36, 70, 108).

Calcium carbide (vol. V, p. 154, 198, 248, 292, 336, 382, 430, 480, 516; vol. VI, p. 39, 86, 132, 170, 218, 264).

Electric furnaces (vol. VI, p. 306, 345, 389, 434, 476, 523; vol. VII, p. 49, 97, 140, 176, 235, 293, 373, 413, 459, 499; vol. VIII, p. 57, 168, 216, 305, 380, 553, 605, 653, 706; vol. IX, p. 58, 116).

Ore treatment (vol. IX, p. 166, 230, 285, 333, 382, 429, 560, 618, 684; vol. X, p. 62, 122, 188, 322, 446, 502, 570, 704, 765, 825; vol. XI, p. 59).

After completion of the patents on Ore Treatment the following subjects remain to be taken up in the Digest: Refining metals (subclass 57); Plating, ornamenting, electrotyping, production of articles, and miscellaneous applications (subclass 1-8, 10-14 and 16-18); Diaphragms (subclass 28); Purifying liquids (subclass 24-26); Tanning (subclass 27).

With the continuously and rapidly increasing importance of electrochemical methods in so many fields of chemical, metallurgical and industrial endeavor, it becomes daily more and more important to be able to find out quickly what was already known in the early history of electrochemistry. Nothing is more convenient or better accessible to supply such information than Dr. Byrnes' Digest covering the field completely and concisely in the volumes of this journal.

Readers' Views and Comments

In Memoriam—Henry de Mosenthal

To the Editor of Metallurgical & Chemical Engineering:

Sir:—In the history of the modern explosive industry a chapter has been closed by the death of Henry de Mosenthal on the 17th of December last from heart failure. Even only a short sketch of his life and work should prove a source of inspiration.

Henry de Mosenthal was born in 1850 at Port Elizabeth, South Africa. He had been associated with Alfred Nobel, the inventor of dynamite, for some years before the formation, in 1886, of the Nobel Dynamite Trust Company, Ltd., of which he was appointed technical secretary from the very first. This position he held until his death.

He was a well known figure in the explosives industry of the world, and his business wisdom and great ability earned for him a high reputation in the business world and in the industry with which he was more especially connected.

De Mosenthal was a Fellow of The Institute of Chemistry of Great Britain and Ireland for twenty years and served for two periods of three years as a Member of the Council. He also belonged to the principal chemical and scientific societies, and will be remembered, not only on account of his connection with the manufacturing aspect of the explosives industry, but also for his valuable scientific work.

Most of his researches were contributed to the *Journal* of the Society of Chemical Industry, and among these may be mentioned the following:

1894, Vol. 13, p. 326—"Treatment of Gold Ore at the Witwatersrand (Transvaal) Gold Fields."

1899, Vol. 18, p. 443—"The Life Work of Alfred Nobel."

1904, Vol. 23, p. 292—"Observations on Cotton and Nitrated Cotton."

1907, Vol. 26, p. 443—"Observations on Cotton and Nitrated Cotton."

1911, Vol. 30, p. 782—"Observations on Cotton and Nitrated Cotton."

The subject of Alfred Nobel was also treated in a biographical sketch in the "Nineteenth Century" of October, 1898, entitled: "The Inventor of Dynamite," and of course, de Mosenthal's intimate relations with Nobel enabled him to write a complete, and one might almost say, classical, biography of Nobel's life and work.

De Mosenthal also contributed articles on "Nitro-Glycerine and Nitro-Glycerine Explosives" and on "Permitted Explosives" to the work published by the explosives section of the Seventh International Congress of Applied Chemistry and entitled: "The Rise and Progress of the British Explosives Industry" (Whittaker & Co., 1909).

De Mosenthal was an expert in microscopy and micro-photographic work, and indeed the earliest of his papers, that on the treatment of gold ore, was already illustrated by micro-photographs. His technique, patience and manipulative skill enabled him to obtain the most remarkable results.

His researches on cotton and nitrated cotton were intended to obtain a picture of the constitution of the cellulose molecule, and he early recognized that the colloidal condition of the substances he examined necessitated methods other than those employed for bodies of a crystalline character. De Mosenthal accordingly determined values for a large number of the physical constants of cotton and of nitrated cotton, and these, together with his deductions, have thrown a good deal of light on this debated question.

In his first paper he was able to show the presence of stomata in the cotton fibre which had until then remained undetected. In his subsequent papers the effect of polarized light on nitrated fibres is described, and the connection between the degree of nitration and anisotropic effect criticised. The density of cotton and of nitrated cotton was determined, and an important difference was shown to exist between the increase in molecular volume with ascending degree of nitration in the case of cotton, when compared with that afforded by the simpler alcoholic nitrates.

The refractive index was investigated, films of the nitrated cellulose being employed, and from the values obtained, the molecular refractions of the di- and tri-nitrates were calculated. The optical activity of nitrated cotton was examined, and its dextrorotatory character confirmed. Work on the dialysis of solutions of nitrocellulose in acetone ultimately established that the substance could not pass through a sound membrane: nor was it possible to detect any osmotic pressure.

In the last paper of the series de Mosenthal applied the results of his work to the nature of the constitution of cellulose, and stated his reasons for considering that it had an open chain structure. Whatever the view which will ultimately prevail, as to whether this or a cyclic constitution is the more rational, the values of the constants determined by de Mosenthal, the description of his methods, and his impartial discussion of the results, constitute a material contribution to the advancement of our knowledge on this difficult subject.

De Mosenthal's papers were the result of much care and infinite thought. It is characteristic that on the day before his death, he discussed his ideas and future programme of research, and it has been arranged that they shall form the subject of a scientific investigation by two of his friends and colleagues as tribute to his memory.

As an illustration of his great versatility it may be mentioned that apart from his scientific work, de Mosenthal published several monographs of a popular nature on explosives in which he exhibited to a remarkable degree his talent for popular exposition of abstruse technical subjects, and for making them understood by the general public. Some of these monographs appeared in the papers of the Savage Club, of which institution he was an esteemed member.

De Mosenthal was a bachelor and a remarkable linguist. He knew the four or five languages which he spoke with a thoroughness as though each was his own, and in addition, he possessed the rare faculty of immediately grasping the vital point in a controversy. He was a trenchant, fearless, yet kindly critic, and he will be sorely missed by a wide circle of friends and colleagues whom it is not an exaggeration to say he could count in every quarter of the globe.

—A Friend.

* * *

The Tungsten-Molybdenum Thermo-Couple

To the Editor of Metallurgical and Chemical Engineering:

Sir: Permit me to correct the rather surprising claim made by Edwin F. Northrup, Ph. D., in your January issue, p. 45, to the effect that he was the one who first suggested this couple at a recent meeting of the Philadelphia Branch of the A. I. E. E. I am sure those present will recall, and if there had been a stenographic record it would certainly have shown, that the proposal to make a pyrometer of these two very infusible metals was made first in my discussion of the papers and not by Dr. Northrup, although he discussed the proposition afterwards together with several others, and told me after the meeting that the idea seemed interesting and that he would proceed to make a trial of one. He certainly did not mention the couple before I rose to suggest it, for if he had there would have been no object in my doing so.

One of the members, in reply to my discussion, stated that he had tried it and had found that there was no e.m.f.; but after the meeting he explained to me that what he had tried was not a couple of these two metals, but something different, namely one between tungsten and some metal other than molybdenum.

After someone has contributed publicly to the profession a suggestion which appears to be of value to his colleagues, it is

almost invariably the case that claimants of priority at once come forth; it is then so easy to *say* that one had done a thing before others announced it, and even to manufacture alleged proofs; in such cases, inquiry generally shows that the alleged prior claimant had something different, probably just short of the successful element, which he then persuades himself to believe was the same, in order to take away the credit from the one who first contributed the suggestion publicly for the benefit of his colleagues, instead of secreting it for his own personal benefit. But whether it is the same or not, such practice should be discredited and looked down upon by the profession, and should be considered as not being in accord with professional ethics. The true professional spirit at such meetings is to exchange views, opinions and suggestions for mutual benefit, and if a member withholds, for his personal benefit, something which is of value to his colleagues (excepting, of course, patentable devices or trade secrets), he is not giving to others what he expects others to give to him at such meetings, and he should therefore be debarred by a code of professional ethics from making prior claims after some less selfish member had contributed it publicly to his colleagues. By secreting such matters one sacrifices his moral right to claim priority afterwards.

In his article Dr. Northrup did not give the complete description which I had given at the meeting. After I had suggested the couple of these two metals because they had a very much higher fusing point than the usual copper alloys and even cast iron and steel, and could therefore be inserted directly into the liquid metals, the question at once arose with what material the wires could be protected from direct contact with the fused metal with some of which they might alloy; one speaker asked me how to make "the hole in the liquid metal," and I then stated that I had found that electrically fused magnesite (which is on the market) withstood steel temperatures very well, and that I had seen tubes made of this material which seemed to me were not too porous. Graphite might answer in some cases.

Of course, such a protecting tube would be essential for the success of such a thermo-couple when it is to be used to plunge directly into the fused metal so as not to have to depend on measuring the temperature by radiation from the liquid surface, which in arc furnaces must necessarily be higher (and probably considerably) than the body of the liquid metal itself, or which in resistance furnaces in which the heat is generated in the liquid itself, would be lower than the metal or the important contact surface of the metal and the slag. In such a furnace the top surface of the slag might even be relatively considerably cooler although the active layer in contact with the steel may be very hot.

Besides this tube I also suggested placing in it some inert material which would either generate a gas which would be inert to the tungsten and molybdenum (hence non-carbonaceous) or would at least consume what little oxygen there was left in the tube, although if the wires were made thick enough that slight amount of oxidation might not be serious. I also suggested glazing the wires with some enamel, if such an enamel could be found.

Since Dr. Northrup found later on that the curve of this couple intersected the zero axis at 1060° C. (see his article) the question arose how a direct reading instrument could be used for a range to both sides of this zero value, as that is the very range for which this thermo-couple was suggested and would be most useful. I then suggested that either the "cold" end might be raised to some known high temperature, which presumably would shift this zero point to a less objectionable region, or an instrument of the Weston type with the point for no current in the middle of the scale, might be used. Apparently the only objection to this would be that up to 530° C. the readings would be wrong (unless indicated by a supplemental scale); but as such a couple would presumably be used only for red and white heats, the eye could be trusted to show whether the temperature was on the upward or downward part of that peculiar curve.

Such an instrument as that here suggested would be of considerable importance for use with furnaces for melting metals, which is the purpose I had in mind; and as it seems promising it is hoped that some enterprising maker will take sufficient interest in it to put it on the market.

CARL HERING.

Philadelphia, Pa.

* * *

To the Editor of Metallurgical and Chemical Engineering:

Sir: After reading Dr. Northrup's article on page 45 of your January issue on "Tungsten and Molybdenum—Their Thermal E.M.F.," I feel that I owe it to the two other manufacturers of pyrometers, who contributed discussions at the meeting referred to, to exonerate them from the odium of making a statement not borne out by Dr. Northrup's subsequent experiment.

First, let me remark that while I made the statement quoted I did not put the emphasis where Dr. Northrup's italics put it. Indeed, the statement has been torn from its context and so given a scientific rather than its obvious commercial meaning. The suggestion of a tungsten-molybdenum thermo-couple was made by Dr. Carl Hering, who complained that makers of pyrometers had so far failed to provide any means of measuring the temperature at the bottom of a bath of molten steel. I stated that the Thwing radiation pyrometer had been used successfully for measuring these and much higher temperatures, and if he would find a tube which would have the necessary mechanical strength to withstand the pressure at the bottom of the bath, I would measure the temperature at the bottom of his tube with ease.

My strictures on the Mo-W couple were based, not alone on its oxidizability, but on rough determinations of the e.m.f. of each of the elements against iron, which showed at the melting point of iron an e.m.f. which was but a small fraction of that given by the platinum couple.

Dr. Northrup's more exact determinations would indicate an e.m.f of about 3 or 4 millvolts, at 1500° or 1600° C., which would be high temperatures for a bath of steel. This is but one-fifth that of a platinum couple, a fact which would doubtless cause this couple to be rejected by any maker of commercial pyrometers, even if it had the needful uniformity and durability.

In the course of two years devoted largely to the investigation of thermal e.m.f. of all obtainable metals and alloys, I could not have failed to discover what any physicist would have assumed a priori, namely, that *any* pair of elements would, at some temperature, give *some* e.m.f. Had Dr. Northrup had the courage to challenge my statement on the spot, he would have had his suspicion that there ought to be *some* e.m.f. confirmed by me, but, in that case, we might have been deprived of his prompt investigation of the problem, which I, for one, should have deplored. By all means let us find a thermo-couple which is good at 2200° C., if there is one, not forgetting, however, to provide a suitable protecting tube at the same time. I have seen a lot of good platinum destroyed in tubes built of "hopes" much less ambitious than those of Dr. Northrup, all in a very short time after they were inserted in a bath of steel.

CHARLES B. THWING.

Philadelphia, Pa.

Waste tin is an important by-product of the northwestern salmon canneries. Scrap tin is sent to Germany, where it is used in the manufacture of toys, and strip tin is shipped to California for use in the manufacture of fruit and berry boxes.

Beds of magnesite of good quality are said to exist in Lower California in the region of Magdalena Bay. Analysis shows these deposits to contain 92 per cent carbonate of magnesium. The largest bed, on Margarita Island, has an area of 30 acres. A company known as La Compania de Desarrollo y Exploitacion de la Baja California, of San Diego, Cal., has been organized to exploit the deposits.

The Western Metallurgical Field

Alaska

Considerable interest attaches to the proposed operations of the Alaska Gold Mines Co., which has recently taken several properties in the Juneau district under its management. A 6000-ton mill is to be built at tidewater, and a 5000-hp. hydroelectric power plant is under construction. The average grade of the ore is $1.50 per ton, and the anticipated cost of mining and milling is placed at $0.75 per ton. Comparison is made with the costs at the Alaska-Treadwell to show that a cost of $0.75 for Alaska Gold Mines is not excessive. Thus, in 1911 the cost of milling at the Treadwell was only 22.52 cents for the 240-stamp mill and 18.20 cents for the 300-stamp mill. The Alaska Gold Mines' 6000-ton mill should equal these mills in point of cheap cost of operation, and consequently 25 cents is considered a fair estimate for this item. This would leave only 50 cents for mining and delivery to the mill, whereas the Treadwell cost for the same operations is about $1. To explain this discrepancy, it is claimed that cost of mining the Alaska ore will not be nearly as great as that of the Treadwell, while the power cost will be limited to interest, depreciation and maintenance of the hydroelectric plant. The entire proposition is one which depends for success on the treatment of a large tonnage at a small margin of profit, and requires an enormous investment.

The value of the mineral output of Alaska for 1912 is estimated by the United States Geological Survey at $21,850,000, compared with $20,650,000 for 1911. The increase is to be credited to the larger copper production in 1912, as gold fell off slightly and silver was only increased by a small margin. The value of all other mineral products showed a slight increase. Information at hand regarding placer operations indicates that gold recovery from this source fell off during 1912; on the other hand, gold from lode mining increased.

There was no abatement in dredge installation on the Seward Peninsula in 1912. During the year 39 dredges were completed or in process of erection, and about 30 were in operation last August. It is significant that these dredges are scattered over the peninsula, in every district where placer gold has been discovered. It is assumed that the production of placer gold from the peninsula has passed its minimum for many years to come.

Revival of the Augustin Process

Fifty years ago the Augustin process of treating silver ores probably was more generally known than it is to metallurgists today. Chloridizing-roasting, leaching with salt water and precipitation of silver on copper formed the basis of the process. Recently a mill has been completed at Park City, Utah, by the Mines Operating Co., for the purpose of treating low-grade ore from the Ontario mine. The first experimental work on this ore indicated probable success with cyanidation, but later it was decided to use the other process mentioned. Details of operation at this particular mill have not been made public, but the revival of the old process is being watched with interest, and it is hoped that success will be achieved.

Mercury in 1912

Preliminary figures collected by H. D. McCaskey, of the United States Geological Survey, from the individual producers show that the domestic production of quicksilver in 1912 was 25,147 flasks of 75 pounds each, valued at the average San Francisco domestic price for the year, $42.04, at $1,057,180. A comparison of these figures with the final published Survey figures for 1911 and 1910 shows a gain over the output of 1911 of 3891 flasks and over that of 1910 of 4546 flasks. Twenty mines were reported as producing in 1912, of which 16 were in California against 22 producers in 1911, of which 19 were in Cailfornia.

American Mining Congress

The work of the last session of the American Mining Congress is reflected in the large number of important resolutions adopted pertaining to the mining industry. There was a notable absence of formal speeches and technical papers, and a corresponding increase in debate on pertinent topics. Among the more important resolutions adopted were the following: Urging the immediate construction by federal aid of two trunk lines of railway from the Pacific coast of Alaska to the great navigable water systems of the interior; protesting against any reduction of the present tariff of zinc and lead; recommending state legislation making it a misdemeanor for any ore-buyer to mix or in any way disguise the identity of a lot of ore before its value has been definitely agreed upon by buyer and seller; urging Congress to provide for federal assistance to state schools of mines; commending Congress for its appropriation to the Bureau of Mines for investigations in metalliferous ores, and asking further increased appropriations; favoring the enactment of laws extending the principle of eminent domain to aerial trams, electric lines and pipe lines; asking the national government to assist in construction of roads through national forests; appointing a committee on mine taxation; suggesting to the President the appointment as Secretary of the Interior of a resident of the public land states, or one familiar with the public land laws.

Activity in Rare Metals

The uranium and vanadium districts of southwestern Colorado and southeastern Utah were the scene of considerable activity during the last year. An inspection of both districts gives the impression that Colorado contains smaller but richer deposits, while those of Utah are more extensive but not so high in grade. The General Vanadium Co. has purchased a large number of claims in Colorado, and has become one of the principal producers. It is difficult to give a statement of the production, as there are several small producers who sell their ores to larger concerns; but it is certain that more work was done and more ore shipped during the past year than ever before. The grade of the ore is generally low; the districts are isolated; transportation is difficult and expensive; and for these reasons development is slow. As the region is quite dry and streams are few and small, additional obstacles are placed in the way of local treatment plants. There is need for a successful system of dry concentration which will raise the grade of the ore and thereby reduce the expense of transportation and subsequent treatment. One new treatment plant was erected and placed in operation last year. It is situated in western San Miguel county, Colorado, near the junction of Disappointment creek and the Dolores river, where the Dolores Refining Co. originally had a mill.

Metal Production Statistics

The preliminary statistics of the United States Geological Survey on metal production in 1912 give some interesting comparisons with 1911. The gold mining industry was about normal, but early figures indicate the smallest production since 1907, when the ouput was worth $90,435,700. In 1912 it was apparently $91,685,168, or over $5,000,000 less than in 1911. The decrease is ascribed mainly to Nevada, and particularly Goldfield, where the production fell off about $4,500,000. A further decrease is noted in Colorado, particularly from the Camp Bird mine, although an increase was noted from the Cripple Creek district. The Survey has adopted the plan of distributing gold production under several heads, as placer amalgamation, cyanidation, smelting, etc., but these figures are not yet available for 1912.

The output of silver was the largest in the past 20 years, amounting to 62,369,974 fine ounces. Only twice since 1892, namely, in 1893 and 1911, has the production been above 60,000,000 ounces, and it is expected that final figures for 1912 will show the silver production to have been the largest in the history of the country. The increase is attributed mainly to the notable increase in copper production from districts in which the ore also carries silver.

Copper production in 1912 was the largest in the history of the United States, and six of the copper producing states, namely, Arizona, Michigan, Utah, Nevada, New Mexico and

Alaska, have each exceeded all former records of production. According to the best figures obtainable, the copper production amounted to 1,249,000,000 lb. in 1912, an increase of over 140,000,000 lb. over 1911. Arizona again holds first place among copper producers, with Montana, Michigan, Utah, Nevada, California and New Mexico following in the order named.

The preliminary figures on lead show a slight decline from the high record of 1911, being approximately 480,965 short tons of desilverized, soft lead, not including antimonial lead. Spelter shows a remarkable increase, stimulated by the high prices for the metal. The production of primary spelter from domestic ore in 1912 is estimated at 323,961 short tons, and from foreign ores at 14,669 short tons, a total of 338,630 tons.

The production of tungsten is estimated at 1290 tons of concentrate carrying 60% WO_3, an increase over 1911. Uranium and vanadium show an increase, although it is difficult to get exact figures. The uranium production is equivalent to 26 tons of uranium oxide, while the vanadium output is equivalent to 300 tons of metallic vanadium. Quicksilver showed the largest production in six years, being 25,147 flasks of 75 lb. each. The principal increase was in California; in Nevada there was a largely increased output.

The Iron and Steel Market

January has brought mixed developments in the iron and steel market, but on the whole the developments are much more favorable than there was reason to expect. The only development which can be considered really unfavorable is that crude materials, coke, ore, scrap and pig iron, have shown an easier market tone. This is not particularly unfavorable, for January normally is a quiet month for all these materials, and nothing approaching a slump has occurred in any of them.

In the steel market proper conditions are all stronger than at the close of December. It is true that there has been a decrease in forward buying of finishd steel products, but this is a function of the distance ahead to which material was already sold. Some market judges appear to think the decreased volume of forward buying betokens uneasiness on the part of buyers because of the change in the national administration, involving the certainty of serious tariff revision among other things, but it is really very difficult to imagine that were this not the case, January would have seen heavy contractng all along the line for third and fourth quarter delivery. The contracting for first half had already been done.

There has been an accentuation of the pressure upon the mills for deliveries. This is seen in two ways. Buyers who had already specified for materials are strenuously representing to mills that they desire better deliveries. Again, there is heavier buying, of early deliveries and at larger premiums. The producing mills are distinctly divisible into two classes, those that sold far ahead upon contract at regular minimum market prices, and those (usually the smaller mills) which held aloof in the expectation of profiting by the premium market which has ruled of late. The strongest pressure is in plates. While the Carnegie Steel Company names a price of 1.45 cents on the limited class of orders it will accept, involving delivery far ahead, and large independents are naming 1.50 cents for somewhat similar delivery, the small independents are able to sell plates in carloads to 100 or 200 tons at 1.75 cents for delivery in four to six weeks, and in similar or larger lots at 1.60 to 1.65 cents for deliveries March to June inclusive. In merchant steel bars similar conditions prevail, and in sheets the character of the market is the same, though the premiums are hardly as large.

Production is at record rate, represented by pig iron being made in January at the annual average of 33,500,000 tons, nearly 4,000,000 tons in excess of the average during 1912, and with steel production proportionately increased. From physical considerations the output cannot be expected to be much larger than this, and under the most favorable market conditions conceivable the present year's production cannot be expected to be above 34,000,000 or 35,000,000 tons.

Pig Iron

Southern pig iron has distinctly softened, as prompt iron of many brands is readily obtainable at $13.50, Birmingham, while some brands of Tennessee iron are purchaseable on this basis for delivery two or three months ahead, and regular Alabama iron for second quarter may easily be had at $14. This represents a clear recession of 50 cents on all positions. History shows that general advances and declines in the pig iron market are led by Southern iron, but all advances and declines in Southern iron are not followed by corresponding movements in the general market. There has been, however, some weakness in Northern markets. Chicago, influenced greatly by Southern iron, which is mixed with Northern in that territory, has shown signs of weakness though quotable prices are not lower. The Philadelphia market has seen some shading, though no general decline. In the Pittsburgh market steel making irons have been firm, but in foundry iron there has been the unprecedented incident of Cleveland iron being offered at 50 cents under the valley parity. This is novel rather than irrational, however, since it is a fact that, considering freights, Cleveland can afford to assemble raw material and deliver pig iron to Pittsburgh about 25 cents a ton cheaper than the valleys, which have controlled the Pittsburgh market from time immemorial. We quote: Bessemer, $17.25; basic, $16.50; No. 2 foundry, $17.50; forge, $17; malleable, $17.25, all f.o.b. valley furnaces, 90 cents higher delivered Pittsburgh; No. 2X, delivered Philadelphia, $18.50; No. 2 foundry, delivered Cleveland, $17.75; No. 2 foundry, f.o.b. Chicago furnaces, $18; No. 2 foundry, Birmingham, $13.50 to $14.

Steel

The famine in unfinished steel, referred to in previous reports has become if possible more pronounced. There is practically no steel available in the form of billets or sheet bars. Of course occasional lots appear, but they are the exception which tests the rule, having in mind particularly how quickly they are absorbed. Thus the receiver of the Southern Steel Company desired to dispose of 5000 tons a month of open-hearth billets over the first half, it being desirable on account of the financial position of the company to have the steel sold, and the material was all quickly taken, the United States Steel Corporation absorbing 15,000 tons for its Pencoyd plant, which should be supplied fully by the Carnegie Steel Company, while the balance was taken in small lots, chiefly by Eastern finishing mills. In Pittsburgh occasional small lots are sold. Ingots have become a market commodity, there being occasional excesses of melting capacity over blooming capacity at points, matched by occasional excesses of blooming over melting capacity at others. Prices cannot be quoted closely, because there is no definite market. In a general way it may be said that billets and sheet bars, if offered, would bring $29 to $30, f.o.b. maker's mill, Pittsburgh or Youngstown.

Finished Steel

Effective January 13, the American Sheet & Tin Plate Company advanced its prices $2 a ton on all regular products except tin plate, and including blue annealed, black sheets, tin mill black and galvanized sheets, carrying also corrugated roofing which are now sold on the basis of flat sheets plus extras. Many of the independents had already advanced their figures, and the advanced figures of the leading interest at once became the minimum of the market. Early in the month cold rolled shafting was advanced two points or $2 a ton to 58 per cent off list in carload lots, delivered in base territory.

Regular prices for forward delivery are given below, plates, bars and sheets commanding a premium for almost any delivery before June, while small premiums rule on some other products. Prices are at Pittsburgh unless otherwise specified.

Rails, standard sections, 1.25 cents for Bessemer, 1.34 cents for open-hearth, f.o.b. mill, except Colorado.

Plates, tank quality, 1.50 cents.

Shapes, 1.50 cents.

Steel bars, 1.40 cents.

Steel hoops, 1.50 cents.

Common iron bars, 1.65 cents, Pittsburgh; 1.60 cents, Chicago; 1.67½ cents, Philadelphia.

Sheets, blue annealed, 10 gage, 1.75 cents; black, 28 gage, 2.35 cents; tin mill sizes of black, 28 gage, 2.30 cents; galvanized, 28 gage, 3.50 cents; painted corrugated, 28 page, 2.55 cents; galvanized corrugated, 28 gage, 3.55 cents.

Tin plates, $3.60 for 100-lb. cokes.

Merchant steel pipe, ¾ to 3-in., 80 per cent off list.

Steel boiler tubes, 3½ to 4½ in., 71 per cent off list.

Standard railroad spikes, 1.85 to 1.90 cents.

Button head structural rivets, 2.20 cents; cone head boiler rivets, 2.30 cents.

The Non-Ferrous Metal Market

There were no unusual features in the non-ferrous metal market in January. Sales of metal were rather below normal, and quoted prices were in many instances discounted in order to obtain business. Domestic consumers seem to buy only for immediate needs and from small agencies. More business was transacted in lead on account of the favorable price, but later in the month this market was dull also.

Copper.—The principal producers have not realized their quoted price. Only a small business in Lake copper is reported. Sales for future delivery have been made at about 17.40 cents, New York, and the market was generally dull. The last quotations are 17½@17¾ cents for Lake and 17.35@17.45 cents for electrolytic.

Lead.—This market has shown a firm tone, but business disappeared when higher prices were asked. The St. Louis market quotes 4.15@4.20 cents, with New York at 4.30@4.35 cents.

Tin.—Early in January there was a slight premium on spot metal, but this later disappeared. Visible supplies at the end of the year were smaller by 5,500 tons than at the beginning of 1912, and it is expected that this will result in an upward movement in the London market. January tin was quoted at 50⅜ cents, New York.

Spelter.—Not much business has been consummated in this market, especially for immediate delivery. Future deliveries are discounted considerably. The market is practically unchanged at the following prices: 7.05@7.10 cents, St. Louis, and 7.10@7.20 cents, New York.

Other Metals.—No material change is noted in aluminium, the last quotations being 26@26½ cents, New York. Sales of antimony have been light, prices ranging from 9 to 10¼ cents for various grades. Business in quicksilver has been light, and prices remain at $40 per flask of 75 lb., New York and San Francisco.

A New Honor for Dr. Acheson

Dr. Edward Goodrich Acheson has been made an honorary member of the Imperial Technological Society of St. Petersburgh, Russia, before which body he delivered an address on the evening of Jan. 20.

American Museum of Safety

On Jan. 23 the American Museum of Safety, 29 West Thirty-ninth Street, New York City, held its annual exercises for the award of its four gold medals.

The *Scientific American Medal* for the most efficient safety device invented during the last three years and exhibited at the Museum's exhibit hall was awarded to the *Draeger Oxygen Apparatus Company.*

The *Travelers' Insurance Company Medal* for the American employer who in the judgment of the American Museum of Safety has done the most for the protection of the lives and limbs of workmen was awarded to the *New York Edison Co.*

The *Louis Livingston Seaman Medal* for progress and achievement in the promotion of hygiene and sanitation and the mitigation of occupational disease was awarded to the *National Cash Register Company.*

The *Rathenau Medal,* placed at the disposal of the Museum by the Allgemeine Elektricitäts Gesellschaft, for the best device or process in the electrical industry for safeguarding industrial life and health, was awarded to Mr. *Thomas Alva Edison.*

Atlantic City Meeting of the American Electrochemical Society

The Spring meeting of the American Electrochemical Society will be held at Atlantic City on April 3, 4 and 5. Headquarters will be at the Hotel Traymore. Members and guests are advised to secure their accommodations early.

No complete program of papers, social functions, and excursions has been arranged so far, but it has been fixed that there will be a symposium of papers relating to the electrolytic decomposition of metals and electroplating, the different metals to be taken up by different authors.

Dr. W. Lash Miller, of the University of Toronto, Ontario, Canada, is the president, and Dr. Jos. W. Richards, of Lehigh University, South Bethlehem, Pa., is the secretary of the Society.

Chemists' Club Library

The library of the Chemists' Club in New York is now getting into fine shape and is being used by a steadily increasing number of members and visitors.

As one fruitful source of criticism of libraries in general is ignorance of the method used by the particular library which is visited by the critic, the library committee has issued the following advice "how to use the library":

"Thanks to the kind co-operation of Dr. Billings, director of the Public Library, and Mrs. Smith, librarian of the Academy of Medicine, any book can be located exactly on the shelf by a system that will never obstruct unlimited expansion.

"To find a book (say, Lunge, Sulphuric Acid, etc.), look it up in the card index by either author, title or subject. Note the class mark (Acd) in the upper corner of the card. Refer to the chart on the card case and find the shelf mark for this class (F 3.5). Go to the stack labeled with this letter (F) on the side marked with the first figure (1-3) to the vertical row of this number counting from left to right (the third) and the shelf of the last number (5) counting from the top down.

"To find all books on a general subject: Look for your subject (or the division that includes it) on the chart, note the shelf number and proceed as above.

"When more than one shelf is occupied by a group, the books are in alphabetical order by authors' names.

"The library is open to the public from 9 a. m. to 5 p. m., except Saturday afternoons, Sundays and holidays; entrance through the public hall and elevators to the third floor."

The Petroleum Industry in 1912

There was no considerable change in the quantity of petroleum produced in the United States in 1912 compared with 1911. Nevertheless, according to David T. Day, of the United States Geological Survey, the year was as full of remarkable incidents as is usual in the history of this article of commerce, which depends for its statistical position more upon the chances of new discoveries and less upon trade demands than any other commodity except gold.

As a rule, the Eastern fields declined in production, because it was impossible to keep up the great output of 1911 without large additional discoveries of new pools in the older fields. The Eastern decline was, however, offset by the increase in California, where the San Joaquin Valley fields (Midway, McKittrick, Maricopa, etc., are still at the height of the gusher stage.

The total production in the United States in 1912 was 220,200,000 barrels (of 42 gallons) against 220,449,391 barrels in 1911. The chief producers were California (87,000,000 barrels), Oklahoma (52,000,000 barrels), and Illinois (28,000,000 barrels).

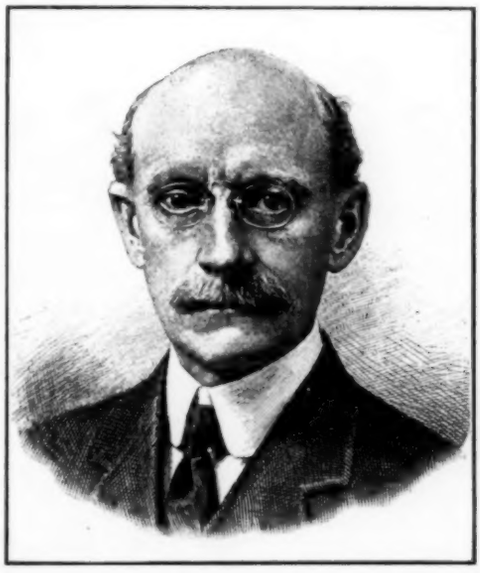
Presentation of the Perkin Medal to James Gayley

The Dry Blast Process as One of the Greatest Achievements in Modern Metallurgical Chemistry

THE Perkin medal was awarded for the present year, to Dr. James Gayley. The medal is awarded annually to a chemist residing in America "for achievements of high value in applied chemistry." The award is made by the Perkin Medal Committee which is constituted of representatives of the different chemical societies of this country. The former recipients of the medal were: Sir William Perkin, Dr. J. B. Francis Harreshoff, Dr. Arno Behr, Dr. Edward G. Acheson, Dr. Chas. M. Hall, and Mr. Herman Frasch. The award to Dr. James Gayley was made in recognition of his dry-blast process as one of the greatest achievements in modern metallurgical chemistry.

The formal presentation of the Perkin medal to Mr. Gayley took place at the meeting of the Society of Chemical Industry held at the Chemists' Club in New York City on the evening of January 24.

Prof. **M. C. Whitaker** in calling the meeting to order emphasized the presence of so many captains of industry who had come to honor Mr. Gayley. He then introduced Dr. **Chas F. Chandler,** the senior vice-president of the Society of Chemical Industry who made the presentation speech.



JAMES GAYLEY

In giving a sketch of Mr. Gayley's life Dr. Chandler mentioned that James Gayley is the maternal grandnephew of Sir Henry Bell, who established steam navigation on the Clyde, where he launched "The Comet" in 1812. He was born at Lock Haven, Pa., October 11, 1855, the son of Samuel A. and Agnes (Malcolm) Gayley. The following brief statement of the successive stages of his professional life are significant:

"Mr. Gayley began his professional life as chemist for the Crane Iron Company, Catasauqua, Pa., 1877-80. He was next superintendent of the Missouri Furnace Company, St. Louis, and later was the manager of blast furnaces, E. & G. Brooke Company, Birdsboro, Pa., 1880-85. In 1885 he became manager of the blast furnaces at the Edgar Thomson Works, and he was subsequently promoted to the position of manager of the Edgar Thomson Works, and he later became a managing director of the Carnegie Steel Company. In 1907, he was made first vice-president of the U. S. Steel Corporation, remaining in this position until 1909."

Dr. Chandler emphasized the enormous importance of the dry air blast and in concluding he presented the Perkin medal to Dr. Gayley with the following words: "It gives me great pleasure, as the representative of the Society of Chemical Industry, and the affiliated chemical and electrochemical societies, to place in your hands this beautiful token of the appreciation and affection of your fellow chemists."

Dr. Gayley replied in a few graceful words of thanks, followed by a most interesting story of the evolution of the dry-blast process. His speech follows practically in full:

The Story of the Dry-Blast Process

By James Gayley

"I wish to thank the speaker for this medal which he has presented to me with such gracious words. I wish also to express my thanks to the awarding Committee and the Societies which they represent in conferring this great honor upon me. I appreciate it still more because the committee have stepped aside from what is purely the chemical industry to another great industry, that of iron metallurgy, which, nevertheless, is one in which the application of chemistry is the controlling factor, and this recognition of the broader field of chemistry brings with it a keen sense of appreciation of this rare honor and distinction conferred upon me. Again I thank you.

"The iron blast furnace is but the chemist's crucible on a gigantic scale—operated on chemical principles and the mechanical appliances are instruments of precision, constructed and adjusted to carrying out in efficient manner the chemical reactions involved.

"The 'rule of thumb' practice, which ended thirty-five or forty years ago, is well nigh forgotten—that period in which chemistry was not applied, and a ton of ore was a ton of ore all the world over, irrespective of its reducibility or chemical composition; when the iron master was more interested in the output of I.x iron than in the fuel consumption, and would tell you that 'lime made heat.' David Thomas, that grand old pioneer of the anthracite iron industry, summed up the requisites for successful furnace practice as 'wind and heat.' The application of chemistry to iron smelting has effected a wonderful transformation in the industry, so that today the chemist occupies the foreground in directing its operations.

"Moisture in the atmosphere has long been recognized as a variable and influential element in the manufacture of iron. Truran, in his 'Manufacture of Iron,' written in 1862, refers at length to the influence of moisture on the quality and make of iron, and the increased consumption of fuel in the summer season, but does not touch on the problem of its regulation or removal.

"Later, in England, it was proposed to extract the moisture by passing the air over lumps of chloride of calcium, but Sir Lowthian Bell showed the impracticability of that scheme on account of the rapidly diminishing power of absorption possessed by the calcium chloride.

"Charles Cochrane, an eminent iron manufacturer of Great Britain, proposed and obtained a patent on extracting moisture from the air by bringing it into intimate contact with liquid calcium chloride flowing over chains suspended in a chamber; but later he declared respecting the benefits to be derived from extracting moisture that 'the game was not worth the candle.'

Nevertheless, the moisture in the atmosphere was recognized as a disturbing element. Some of the earlier makers of anthracite iron in the Lehigh Valley stated that they frequently knew in the morning what kind of iron their furnaces were making by observing the weather conditions; yet, prior to the first dry-air installation in 1904, this variable element of moisture was accepted in a spirit of resignation, as something to be endured, like storm and sunshine, a condition beyond control.

"It was my privilege to be invited in 1885 to take charge of the Edgar Thomson blast furnaces of the Carnegie Steel Company, a plant which represented the most advanced construction in blast furnace equipment, and was supplied with the best fuel and ores. In the operation of these large furnaces, the influence of the atmosphere was forcibly impressed, as the steel works were being supplied with hot metal direct from the furnaces, for the Jones metal mixer had not come into use. It was a difficult matter to supply metal approximating uniformity even under the best conditions, and quite impossible under conditions of varying atmospheric humidity.

"For several years observations were made twice a day of the moisture in the atmosphere, and a direct relation was established between the quantity of moisture and the grade of metal, with particular reference to the silicon which is the heat-producing element in the acid Bessemer converter. In the summer season, the air blown into the converter was heavily charged with moisture and, in consequence, a higher percentage of silicon in the metal was normally required, while at the same time these atmospheric conditions operated on the furnaces to produce a lower-silicon metal; thus the operating of furnaces in conjunction with Bessemer converters on direct metal may well be presumed to have been a difficult and trying proposition.

"Under these conditions of manufacturing, the removal of the moisture from the atmosphere, or rather its reduction to a low degree, and one of practical uniformity, appeared to hold out the only means of effecting regularity, and at the same time to promise a considerable saving. It was a matter of constant observation that a sudden change in the weather, making a quick drop in the temperature and content of moisture, would cause the furnaces to work excessively hot, but this period of dryness could not be taken advantage of, for before any changes could be made effective in the furnace charge to meet current atmospheric conditions the moisture might have increased to its normal seasonable amount.

"Observations of the humidity in the atmosphere were made daily from 1886 to 1890, when the first experiments for moisture removal were begun. These observations were made at the beginning in the morning and evening, and later were made every hour. Observation was also made of rainstorms to determine the moisture before, during and after the rain, and it was noted that the moisture usually dropped quickly as the rain began to fall. Throughout this period of moisture tests, the working of the furnace was observed in its relation to the amount of moisture in the atmosphere.

"A modern furnace consumes about 40,000 cu. ft. of air per minute, and for each grain of moisture per cubic foot there enters the furnace 1 gal. of water per hour for each 1000 cu. ft., that is, if the moisture was 1 gr. per cu. ft., 40 gal. of water would enter the furnace per hour. The variation of moisture from month to month in the Pittsburgh district is shown in the following table:

	Average Temperature. Degrees Fahrenheit.	Weight of Water Per Cubic Foot of Air. Grains.	Quantity of Water Entering Per Hour Into a Furnace Using 40,000 Cubic Feet of Air Per Minute. Gallons.
January	37.0	2.18	87.2
February	31.7	1.83	73.2
March	47.0	3.40	136.0
April	51.0	3.00	120.0
May	61.6	4.80	192.0
June	71.6	5.94	237.6
July	76.2	5.60	224.0
August	73.6	5.16	206.4
September	70.4	5.68	227.2
October	56.4	4.00	160.0
November	40.4	2.35	94.0
December	36.6	2.25	90.0

While the moisture in January averaged 2.18 gr., yet the total variation for the month was from 0.56 gr. to 2.55 gr., and while June shows an average of 5.94 gr., yet the extreme variation was from 4.8 gr. to 8.50 gr., or, in other words, the moisture entering the furnace varied from 192 to 340 gal. per hour. During the midwinter period the moisture may vary as much as 150 per cent in the same day, but in midsummer it rarely varies more than 25 per cent.

"Having secured extensive data on the varying humidity of the atmosphere over a period of five years, the problem of reducing the moisture and making it uniform next presented itself.

"The experience of English engineers was against the absorption process with calcium chloride, and my predecessor at the Edgar Thomson Works, Mr. J. H. Cremer, had constructed an apparatus to dessicate in the same way, but he obtained very unsatisfactory results. As our observations showed a reduction of moisture through a reduction of atmospheric temperature, the reduction of temperature through mechanical refrigerators presented itself as the obvious method of removing the moisture; and on this basis the first experiment was undertaken in 1890 in a crude way.

"We began by passing air through two chambers in succession; in the first chamber the air came in contact with pipes cooled by water, and in the second chamber anhydrous ammonia was expanded through the pipes. As the air came from the blowing engine it was quite warm, but after passing through the chambers it was very cold; each chamber was only 6 ft. long and the volume of air treated was small, indeed.

"Various forms of apparatus were constructed from the period of 1890 to 1895, and tests were made as opportunity offered. During this period my duties had been changed from that of superintendent of the furnaces to general superintendent of the whole works, thus adding to my duties that of the steel works and mills. There was in consequence not much time free to make experiments, for the demands of a large steel works on its manager's time were persistent and exacting, and experiments and improvements along other well-defined lines represented more immediate profit and demanded thought and attention. But the general plan for a final test on a large scale had been worked out, which was to be tried later. In 1896, I left the active management of the works to enter upon the general business of the Carnegie Steel Company in connection with the ore department and the assembling of all raw materials. If the opportunities for experimenting were rare when stationed at the works, they became more so when located in the general office.

"I therefore secured the services of a young engineer, Mr. Walter, from a refrigerating company, and when they learned the nature of my experiments they kindly loaned me a small ammonia compressor to carry on the work. We used two air-drying chambers, each 4 ft. square and 8 ft. long, and filled with pipe coils, and equipped with the necessary refrigerating appliances. A blast engine with an air cylinder, 3 ft. in diameter and capable of supplying 3500 cu. ft. of air per minute was installed, and from this engine and its small air supply the data was worked out for treating 40,000 cu. ft. of air, which was the quantity required to supply a modern blast furnace.

"I mention that we had to work out the necessary data for a practical demonstration, and the suggestion might arise, why did we not avail ourselves of the experience of refrigerating firms? Indeed, we tried. The proposition was put up to several important makers of refrigerating machinery, but without any substantial benefit. To refrigerate the air for cold storage rooms was a specification they readily understood, but the treatment of a hurricane of air was an entirely different problem to them. We were, therefore, compelled to work out the data ourselves and make our own card of estimate.

"It is unnecessary to give in detail the many and varied experiments made in treating the air, nor to describe how certain obstacles, which seemed to block our progress, were successively overcome. In our list of experiments we tried rarefac-

tion with refrigeration, but we did not obtain satisfactory results.

"For quite a period the chamber into which the cold air was discharged accumulated a large quantity of snow, and the air flowing in produced a veritable snowstorm. This was delightful on a hot July day, but unless we could overcome this snowstorm it would be disastrous to the process, for the snow would soon become aqueous vapor. We tried to extract it from the air, but without success.

"The essential thing was not to produce it, and in this we were finally successful. We were trying to refrigerate to a very low and unnecessary degree and the frost did not become fixed on the cold pipes; by increasing the temperature of the brine circulating through the pipes the snow became fixed and promptly disappeared from the cold air blast. We worked generally under conditions of the highest humidity in the Pittsburgh district, which we secured by admitting steam to the air inlet when necessary.

"About the year 1900 we had plans worked out in detail for a plant to treat 40,000 cu. ft. of air per minute, and I then applied to my company for an appropriation of $100,000 to make this installation, and here my most difficult work began—to persuade my associates that moisture in the air could appreciably, even in a small degree, affect the working of a blast furnace.

"It could hardly be expected that men who came up through the ranks of the steel works or office should appreciate the influence of atmospheric changes on a blast furnace that to all external appearances was crude and rough, but which in its interior adjustment was really on a most delicate balance. Money was readily appropriated for the mechanical appliances of the furnaces, or for securing uniformity in the physical and chemical composition of the ores, coke, and limestone, and a variation therein of 10 per cent to 20 per cent was promptly corrected, but the atmosphere might vary from 20 per cent to 150 per cent even in a single day without giving any concern, for few realized that the weight of air consumed per ton of iron was 50 per cent greater than all the other raw materials combined.

"It was not until 1903 that I secured an appropriation to construct the first plant, although I had offered two years before to assume personally half the expense.

"Early in June, 1904, the dry-air plant, which was erected at the Isabella furnaces at Pittsburgh, was in proper working order and ready to be put on the furnace. It was necessary to apply the dry air gradually so as not to disturb the furnace adjustment, and as there were three blast engines we arranged to first supply dry air from one engine, making the blast one-third dry air. We decided to apply this dry air at 9 a. m. and I had the weight of ore charge increased by 5 per cent, and this increase was timed to reach the combustion zone of the furnace at 11 a. m. The furnace manager protested against the addition of 5 per cent, contending that a 2 per cent increase was about the limit, and if the dry air did not prove efficient he would then have a very cold furnace on his hands. Notwithstanding the objection, the increase was made. When the dry air was turned on at 9 a. m. the furnace soon showed the effect of it, the gas became grayer, a sure sign of the furnace working hotter, and when the 5 per cent increase in ore had reached the hearth it was not discernible that the furnace had been given an increased duty.

"The operations of the furnace were conducted on a conservative basis, and the long time spent in working out and developing the air-drying plant was rewarded, for the plant started and continued to perform its work without a hitch. By the sixth day the furnace was being supplied with two-thirds dry air and one-third natural air, and 9 per cent increase in ore charge had come to work; and the furnace condition was splendid. I might add here that the 9 per cent increased weight of ore charge represented the same percentage increase in output and a like reduction in the amount of fuel used per ton of iron.

"On the afternoon of that sixth day in the use of dry air I left the works well satisfied with the progress made and confident of the future by reason of the many little indications easily recognized by practical furnacemen that a still heavier duty would be responded to.

"I had not gone far when the sound of an explosion reached me, and, on turning, I saw great clouds of steam rising from the works. I hastened back, and feeling my way through steam and dust, I was dismayed to find that the refrigerating chamber had collapsed.

"There it lay, a tangled mass of concrete and distorted pipe coils.

"The building gave way because during a part of the time employed in erecting the dry-air plant there was a bricklayers' strike and the works manager not wishing to delay construction built the refrigerating chamber of concrete. The dry-air blast conduit leading from the top of the chamber to the blast engines was constantly vibrating from the impulse of air and the vibrations of the engines. These vibrations were in turn communicated to the dome of the building, weakening the bond of the concrete and caused the walls to collapse, which in their fall broke the steam pipe leading to the compressors. The débris was cleared away, and in less than two months the plant was again started.

"We began as before and in two weeks' time had secured a fuel economy of 15 per cent, and then by small increments we gradually worked up to a point of 20 per cent efficiency. That is, we effected a fuel saving of 20 per cent and increased the output to the same extent. This practice was continued for about six months, but the manager thought it was operating too close to the danger line to take care of irregularities in the raw materials, and the fuel economy was adjusted to 15 per cent. Even with dry-air blast there is a disinclination to work up to the high limit of efficiency, for the prior experience of every furnace manager with natural air had shown the necessity of keeping a good margin of safety."

Mr. Gayley then exhibited two models of apparatus for drying air. In the first model, which represented his first installation, there is a chamber filled with pipes and the air is cooled by indirect contact with a cooling fluid, which is brine. The temperature of the brine is such that the air entering the chamber at 80 deg. is discharged at 23 deg.

The second model represented the two-stage process in which the air is brought into direct contact with refrigerated water in the first chamber and is reduced to about 35 deg. in temperature, then it passes to the second chamber filled with pipe coils through which brine circulates and the final temperature is obtained. The two-stage method is more cheaply operated and costs one-third less to build.

"It was not our purpose throughout our experiments to work out the most economical method of drying air for the first installation. What we aimed at was to construct a plant that would efficiently and continuously produce dry air in order to determine its economical value in the furnace."

Mr. Gayley then showed a chart which illustrated the variableness of moisture in natural air and the regularity of dry air. During the thirty-one days of July, 1910, the moisture in the natural air averaged between 3½ and 8 gr. per cubic foot of air, while the moisture in the dried air of the dry-blast process was uniformly equal to 0.8 gr. of moisture per cubic foot of air. In other words, with dry blast 800 gal. of water were delivered to the blast furnace every twenty-four hours, while with natural air the amount of water delivered would have averaged between 3400 and 7800 gal. per twenty-four hours.

"The records obtained at several works from the use of dry air, and which in each case cover a considerable period, are as follows:

"Works A—Obtained a decrease on coke consumption of 10.5 per cent and an increase in output of 23 per cent.

"Works B—Obtained a decrease in coke consumption of 6 per cent and an increase in output of 15.3 per cent.

"Works C—Obtained a decrease in coke consumption of 9.8 per cent and an increase in output of 11.8 per cent.

"Works D—Obtained a decrease in coke consumption of 10.5 per cent and an increase in output of 16 per cent.

"The results obtained at different plants are modified by the raw material used, and the personal equation of the management enters into it.

"The results given above are taken from works in three different countries. *The claim I personally make for the process is that with an increase in output of* 10 *per cent the saving in fuel per ton of iron will be reduced* 10 *per cent, and I consider this conservative.*

"One of the advantages obtained through dry air is the elasticity it permits in the furnace operations to meet business conditions. If trade is dull the furnace can be operated to secure the maximum of fuel economy with a small increase in output, but when trade is 'booming' and pig iron is in demand, and increased output is more desirable than a saving in fuel, the furnace can readily be made to respond.

"The manager of the Dowlais Works, at Cardiff, Wales, experimented with one furnace to determine what results could be obtained under each condition of operating.

"For a period the furnace was operated principally to secure increased output and obtained an increase of 26 per cent with a fuel saving of 12.3 per cent.

"In the next period they operated principally to obtain decreased fuel consumption and obtained an increase in output of 12 per cent with a decrease in fuel of 17.4 per cent.

"In addition to the the advantages from dry air already mentioned, it is found that the furnace works with greater regularity and in consequence a more uniform metal is produced, and a required grade of metal can be made with precision.

"In low-silicon irons the sulphur does not increase as it does when natural air is used.

"The saving in coke effects a corresponding saving in the limestone necessary to flux the ash of the coke, and there is less phosphorus entering the metal.

"As the furnace charges settle more regularly, there is less fine ore carried over with the gases.

"A manager of blast furnaces using dry air recently said that they found it to be an 'educator' in their practice, as it had taught them the advantage of securing regularity in many other directions.

"I shall not attempt herein to set forth any of the theories advanced to account for the fuel saving, which has been found to be in excess of what is necessary to dissociate the moisture. That feature has been ably discussed by Dr. Henry M. Howe, Prof. J. W. Richards, Mr. J. E. Johnson, Jr., and many others in this country, and also by metallurgists in England, Germany, and France; and their full discussions can be found in the transactions of the American Institute of Mining Engineers, the *Journal* of the British Iron and Steel Institute, and metallurgical journals.

"Towards a full consideration of the dry-air blast, a few points may be referred to briefly:

"It did not come into its work as did the Neilson hot blast in 1828 when the art was crude and the appliances of the furnace were poorly adapted to the work. But to the Scotchman Neilson all credit is due for effecting a fuel saving of 30 per cent.

"The dry-air blast was tried out when the equipment of the furnace was as perfect as human skill could make it. The chemistry of furnace operations was well understood and its management was on a skillful and scientific basis.

"Again, it was not possible for dry-air blast to have an experimental stage. Nearly every device or process can be tested in an experimental way and on a comparatively inexpensive scale. Bessemer could blow air through molten metal in a pot and demonstrate the value of the pneumatic process, but it would have been of no value to build a small plant to refrigerate a part of the air; nothing conclusive would have been shown. Nor would it have been of any value to treat the whole air supply of a diminutive or toy furnace. To efficiently demonstrate its value it had to be applied to a furnace that was equipped and operated according to the most advanced state of the art, and not only was it essential that the whole air supply should be treated, but also that the method and means of treatment should measure up in capacity and efficiency and operate as continuously as any of the other accessories of a modern blast furnace. To achieve this it required time, patience, and many experiments, and now with its accomplishment, in removing irregularity from the most important and invariable factor in the winning of iron from its ores, it apparently removes the last barrier toward the attainment of ultimate economy in the present field of practice.

"This, in brief, is the story of the dry-air blast."

Addresses by Prof. Howe, Dr. Hart and Dr. Raymond.

Prof. **Henry M. Howe,** of Columbia University, followed with a brilliant address on the metallurgy of the dry-blast process, spiced with sarcasms on the light which the development of the dry-blast process has thrown on the value of expert opinion.

A saving of fuel of 20 per cent or 10 per cent had been considered as preposterous, as absolutely impossible. But then it became a fact. "Let us learn the lesson of humility." Now as the heat required for heating and dissociation of the moisture is so very small, how can the big saving in fuel, due to dry blast, be explained? Dr. Howe emphasized the supreme importance of temperature. There is a critical temperature in the blast furnace reaction and accordingly there is hypercritical and hypocritical heat and hypercritical and hypocritical work, and any charge of the ratio of hypercritical to hypocritical heat has its effect.

We hope to publish Professor Howe's address in a future issue.

Prof. **Edward Hart,** of Lafayette College, followed with an address on "Dr. Gayley's Interest in Education." Professor Hart told of what Dr. Gayley has done for various institutions of learning in this country. His speech was delightful, as he told of many humorous and intimate reminiscences from Mr. Gayley's early life. While Professor Hart was Mr. Gayley's teacher in chemistry, yet he emphasized that Mr. Gayley had always been highly original and was in many ways a self-educated man. One of Mr. Gayley's chief traits of character was his consideration for other people's feelings.

The session was concluded by an eloquent and highly poetical speech by Dr. **Rossiter W. Raymond** on the present time as a "new age."

Old Freibergers in America.

On Friday evening, Dec. 20, at the Hofbraü-Haus, Broadway and Thirtieth Street, New York City, a number of old students of the Freiberg Berkakademie sat down to dinner. This meeting was called for the purpose of forming an association in America to be known as the "Old Freibergers in America."

After the dinner a business meeting was held and the following officers were elected: President, R. W. Raymond, Freiberg, 1861; vice-president, Gardner F. Williams, Freiberg, 1868, and secretary-treasurer, C. L. Bryden, Freiberg, 1907.

It was decided to hold two meetings a year, one on March 25, the anniversary of the founding of the Akademie, March 25, 1765, and the other on Dec. 20, this to be the annual meeting.

The following members were present: Dr. R. W. Raymond, 1861; Gardner F. Williams, 1868; P. J. Oettinger, 1867; Stuart M. Buck, 1868; T. Waln Morgan Draper, 1876; Baron Alfred von der Ropp, 1882; Franklin Guiterman, 1877; F. G. Corning, 1879; R. Boice, 1908; Albert Meyer, 1908; R. M. Payne, 1909; Dr. E. E. Lungwitz, 1886; F. H. Sistermans, 1885; George M. M. Godly, 1900; Walter V. Rohlffs, 1903; H. H. Knox, 1886; H. A. Wilkens, 1889, and C. L. Bryden, 1907.

All old Freibergers who have not already done so are requested to send in their names and addresses to the secretary, C. L. Bryden, 1015 Myrtle Street, Scranton, Pa.

Utilization of Waste Wood

Raw Materials

By John E. Teeple, Ph.D.

For the purposes of this article we will include under the term "Raw Materials of Wood Waste," saw dust, ends, slabs and edgings from lumber mills, stumps from lumbering operations, and fallen or dead timber in the woods, caused by storms, and not suitable for lumber. We do not include the tops and branches of trees cut for lumber and left in the woods, because no suitable method has yet been worked out for rendering them commercially valuable, and we do not include young trees, particularly of short-leaf pine such as are used for making paper pulp to some extent, because it permitted to grow they would eventually be suitable for lumber.

In kind, waste wood may be the long-leaf pine of the South Atlantic and Gulf States; short-leaf pine of the same general region, and various other pines intermediate between them in characteristics; Oregon pine or Douglas Fir of Oregon, Washington and British Columbia; Norway or red pine of Ontario, Manitoba, Minnesota, Wisconsin and Michigan; and hardwood of many parts of the United States and Canada.

This gives us at least four forms, viz., saw dust, slabs, stumps and fallen timber, and at least five classes of wood.

It is obvious that the recovery of valuable materials from short-leaf pine, saw dust for example, is an entirely different problem from that presented by long-leaf pine stumps, which is again different from the treatment of hardwood slabs. In fact, this simple classification into four forms and five kinds of wood presents of itself twenty distinct problems.

The situation is further complicated by differences in each class; long-leaf pine stumps for example differ widely in composition, depending on age, soil, elevation of the land, latitude, and probably on the season of the year when the tree was cut.

When any proposition for utilizing wood waste is presented then, the question of form and kind of raw material and location becomes exceedingly important. The only safe assumption is that conditions in any one place are not identical with those in any other place. The individual problems presented are practically as numerous as the individual locations and conditions. These differences must be taken into account and studied carefully before any specific plant can be designed, or any particular process recommended intelligently for the case in hand.

Given a general class of conditions, one can outline a general plan of plant, or predict the probable success or failure of a general idea when applied to those conditions. He cannot go much farther than this without a careful examination of the specific raw material and location. Too often success or failure depends on specific adaptation to individual local details, and not on general ideas applied to general conditions. This is especially true in this industry, dealing as it does with bulky materials not easily transported, not permitting much in the way of handling charges, yielding comparatively small amounts of products and those products not universally salable, often none of them salable within hundreds of miles of the point of production.

We cannot then give too close attention to raw materials, and it may be necessary or advisable in a particular case to reject one-half or nine-tenths of the waste offered in order to work successfully with the remainder.

No matter what form or kind of wood is presented within the limit specified above, we may for our purpose consider it to be composed of three parts: First, water; second, structural frame work, and third, gum resins. The first part, water, may form anywhere from 25% to 50% of the weight of the wood. It is often given a high value in the prospectus, but the demand for it seems to be rather light. The second constituent, the structural part of the wood, consists essentially of cellulose, various lignocelluloses, and similar products chiefly carbohydrates. This makes up the wood itself. It is the frame work, the part that gives it texture. It is, of course, present in all woods, and, in many of them, particularly in the hardwoods, there is no other important constituent present excepting this cellulose framework and the water. The third constituent of the wood is resin or gum resin. This affects the color and weight of the wood, and is a deposit in the interstices of the woody framework.

When extracted from wood, the gum resins may be easily separated into turpentine, pine oil, and rosin. In pine woods, the first or volatile part of the resin is turpentine, or a mixture of terpenes, the kind and quantity of the different terpenes varying in different species of pine. The second part, still volatile but boiling at a somewhat higher temperature than the turpentine is pine oil. It consists essentially of hydrolytic and oxydation products of the terpenes. Most of the pine oil constituents contain oxygen. The third part of the gum resin deposit is rosin. This is the solid part not easily volatile with steam. Rosin is a mixture of different resins in different species of pine. The gum resins were the first products that led to the utilization of pine wood for uses other than lumber, and they still give the main value to waste wood. Considering the importance of the gum resins, it might be well to devote some attention to their origin and formation if we had any definite information about them.

If we make an incision into the pine tree it will nearly always produce a flow of sap or oleoresin or gum resin of a semi-liquid character, consisting of terpenes and rosin, no appreciable amount of pine oil. At the same time there is an increased deposit of gum resins in the body of the tree itself in the neighborhood of the wound. It seems probable that the oleoresin flowing from the tree is a combination of the natural sap of the tree and of another secretion formed to protect and reinforce the tree in the neighborhood of the wound. In case this wounding or chipping is continued from year to year, as is done in tapping trees for turpentine, the amount of deposit in the tree in the neighborhood of the wounded part becomes very large. The wood becomes so pitchy, or fat, that the butt of the tree is not suitable for lumber, particularly on the outside, and we have box faces or fat slabs which form a part of the waste of mills cutting long-leaf pine that has been chipped for turpentine.

When a long-leaf pine tree is cut in the woods, leaving a stump, the same process seems to go on in the stump. The sap wood gradually rots away, and the heart of the stump becomes richer and richer in gum resins as the years pass, producing finally what are known as fat light-wood stumps. This same thing occurs when a tree is blown down by storms, or if it dies standing, particularly where it has previously been tapped for turpentine. In some cases the stump becomes rich in gum resins down below the surface of the ground throughout most of the length of the tap root. In other cases there is no appreciable deposit of gum resin below the level of the ground. In the case of Douglas fir the deposits of gum resin are mainly in pockets produced by wind shakes, instead of throughout the framework of the tree itself, and this makes the yield of gum resin from that species very much more irregular than is the case with the long-leaf pine.

The fact that pine oils are important constituents of the gum resins extracted from old wood while they are scarcely present in the oleoresins obtained from the live tree by chipping it is probably due to slow processes of oxydation and hydrolysis going on in the stump or wood in the forest.

In the matter of cost: Waste from mills can usually be had at an exceedingly low figure, sometimes for nothing. The amount of waste usually considerably exceeds the amount required for fuel, and it often becomes a source of expense to take care of the remainder. The privilege of collecting fat light wood in the woods may usually be obtained at a cost of 10c to 25c per cord. Stumps can ordinarily be obtained for nothing, and if they are to be pulled out or cut off far enough below the ground so as to make the land tillable, the owner is often willing to pay $8.00 or even $12.00 per acre to have them removed.

The utilizable constituents of wood waste then are essentially the framework, which we call the celluloses for briefness, and the gum resins. The latter can be separated easily into turpentine, pine oil, and rosin. These are the only products existing in the wood in commercial quantities, or obtainable from it without using temperatures high enough to effect decomposition of the celluloses, rosin or oils.

The hardwoods contain no appreciable amount of gum resins, so the products derivable from them are, roughly speaking, only the products that could be derived from any other type of cellulose, for example they may be distilled to produce acetic acid, wood alcohol, tar and charcoal; they may be treated with alkali for conversion into oxalic acid; they may be treated with sulphuric acid for conversion into ethol alcohol. Some of them may be treated with soda, sulphite or sulphate for conversion into paper pulp. The yields in any or all of these cases, of course, will vary widely, depending on the nature of the hardwood.

The short-leaf pine contains a very small amount of gum resins, and also ordinarily contains more water than the hardwoods. The gum resins being in small amount are a disadvantage, because they contaminate the other products, and the yields both in quantity and in quality are liable to be inferior to those obtained from hardwoods, under similar conditions. So far as I know short-leaf pine waste is not being utilized at the present time, excepting for the production of ethol alcohol and paper pulp.

Long-leaf pine, Douglas fir and Norway pine may be classified together in this general way: If they are poor in resinous materials, then they can only be treated for the products obtainable from hardwood, and the products are liable to be inferior in quantity and quality, as stated under short-leaf pine. On the other hand, if they are rich in resins, this gum resin may be extracted direct and converted into any of the forms into which rosin, pine oil, and the terpenes are convertible, or the whole mass of wood may be treated together by distillation or otherwise, in which case we get various mixtures of products similar to those obtainable from hardwoods, with other products obtainable from the resins. This last method, unfortunately, has been the one most commonly adopted in the past, with the result that products of wood distillation too often have a reputation for indefinite and varying composition. In most cases it would be just as easy to separate the gum resins from the celluloses beforehand and to convert these separately into definite, uniform, marketable goods.

No account has been taken in this article of the mineral constituents of wood, nor of the various extracts which may be obtained from certain woods, like the oak and chestnut. The recovery of mineral constituents is not liable to become a factor in the near future, and extracts are not ordinarily produced from materials that would generally be classed as "waste wood."

The chief intent of this article has been to call attention to the wide variation of character in raw material presented, and the necessity of applying in each case the type of treatment which will be specifically adapted to the character of the raw material.

New York City.

The 1913 calendar of the **Brown Instrument Company,** of Philadelphia, Pa., shows a picture of the U. S. S. *Wyoming*, largest warship in the world, making 21 knots on her trial trip. There are Brown pyrometers used on the *Wyoming* for indicating the stack temperatures.

Mr. **William E. Hartman,** consulting engineer and expert in the construction of gas ovens and coke ovens, has been retained by the Gas Machinery Company, Cleveland, Ohio, with its oven department. Mr. Hartman was formerly associated with the H. Koppers Company, of Chicago, first as gas engineer in the construction of by-product coke ovens, and lately as managing engineer. A very interesting paper by Mr. Hartman on by-product coke ovens in America, was published in our Vol. X, p. 521.

Sewage Purification

A Description of the Chemproco Sewage Disposal System

By James Millar Neil

Among sanitary engineers it is generally conceded that sewage consists practically of a mixture of 998 parts of water, one part of mineral matter and one part of organic matter, also that when reference is made to sewage purification, the same refers solely to this 1/10 per cent of organic matter which also includes the germ life.

Unfortunately, heretofore, no method in actual commercial operation eliminates completely all of this 1/10 per cent of organic matter contained in sewage, the difficulties encountered being the elimination of the soluble organic compounds and separation of the colloids from the treated sewage.

An ideal sewage purification process should possess the following advantages: The operating costs must be low; the plant required must have a low initial cost; the space required for the installation must be small; any reagents used must be low in cost; the resultant sludge must be easy of disposal; the effluent must be clear and harmless; the method of separating the solids from the liquid must be rapid and effective; under certain conditions the excess reagents in the sludge must be easily and cheaply recovered for use; the treatment operation and final products must be odorless.

The great defect in all present methods of sewage purification is that of filtration, and it is surprising to find how little ingenuity has been brought forward in solving this problem—every attempt at solution has been in the direction of sand filters, etc., with the corresponding technical difficulties pertaining to their satisfactory working and the enormous area of land required.

Sewage today can, however, be rapidly or, in fact, instantaneously purified, meaning thereby the complete separation of all of the solid matter contained therein, precipitation and separation of the organic matter, and the discharging of an effluent clear, odorless, and harmless. This result is obtained partially through the combination and application of the well known Moore suction filter, and a novel method of precipitation and separation of the organic and solid matters contained in sewage.

The operation of the process requires the use of suction pumps and vacuum filters, whose surfaces are permeable to liquids and impermeable to solids. The type of vacuum filter preferably employed is what is known in the arts as the Moore movable suction filter, as it allows of the separated solids being easily removed from the sewage treatment tanks at will.

By means of this process it will be found that not only are all of the conditions fulfilled for an ideal sewage purification process, but that its operation is simplicity itself.

The process consists essentially of the following steps or stages:

1st. The passage of the crude sewage through a screen or screens in order to remove the floatage and other large bodies contained therein.

2nd. Aeration in order to supply the amount of oxygen requisite for the complete precipitation of the organic matter and at the same time to maintain the contents of the sewage treatment tank in a state of agitation and thereby break up and granulate the solids, also for the purpose of commingling the precipitable and fatty matters with the precipitant so as to render them in a condition suitable to collection on the filtering medium employed.

3rd. Treatment of the sewage preferably while in a state of agitation by the requisite precipitating chemical reagents.

4th. Separation of the liquid from the solid matter in suspension in the treated sewage by means of filtration, instantaneously affecting the precipitation of the unprecipitated organic matter which heretofore has not been accomplished by any sewage purification process.

5th. Discharging of a clear, odorless and harmless effluent.

6th. Discharging a cake containing the impurities of the sewage and also containing the excess of chemical reagents used in the process.

7th. Recovery of the chemical reagents from the discharged cake for reuse in the process.

Before describing the individual steps or stages as they occur, a brief outline of what is meant by a Moore suction filter will facilitate the understanding of the operation of the process.

Fig. 1 is an illustration of a Moore filter leaf, which consists of a rectangular frame of tubing, enclosed by sheets of filter cloth suspended vertically from a rigid bar or header, the end sections or side tubes of the filter frame and canvas extending through the bar or header as shown in the illustration. The side tubes of the frame have no perforations, whereas the bottom pipe is usually slotted or channeled.

The filter cloths or canvas are reinforced by means of rows of stitches and stiffening or separating strips preferably of wood, which maintains the rigidity of the canvas or filtering medium when either pressure or vacuum is applied. As shown in the illustration, one of the side tubes is connected to a main

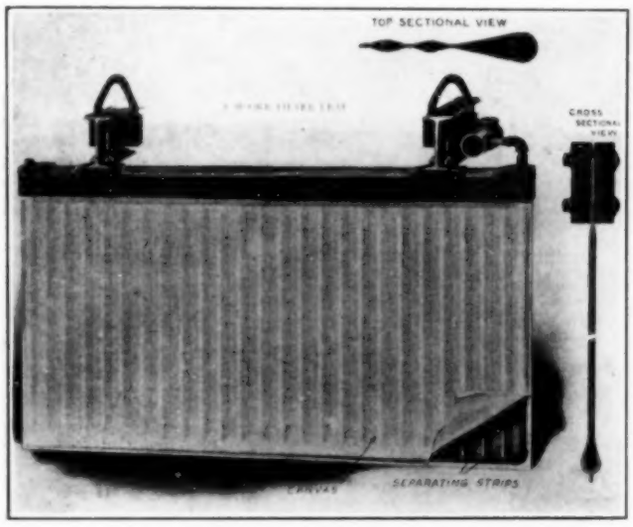


FIG. 1.—MOORE SUCTION FILTER LEAF

pipe or vacuum header connected by means of a flexible tube to the suction end of the vacuum pump. These leaves are made in any desired size, according to the filtering area required. This form of filter leaf gives an enormous filtering area, occupying very little space.

These filtering leaves are usually in practice coupled up in any desired number, and as such are known as a "basket." Fig. 2 illustrates a basket ready for use.

Fig. 3 illustrates a basket of leaves in place in a treatment tank, and a basket suspended out of the treatment tank by means of a traveling crane.

Fig. 4 is a side view of a complete sewage treatment plant, and shows the different steps of the process as set forth in the following description:

The operation of a Moore filter leaf is extremely simple. When the vacuum or suction is applied, clear liquid is drawn through the filtering cloths or canvas, depositing on the surface the solid matter in suspension in a cake of uniform thickness. The clear liquid in passing through the filtering medium is drawn through the slotted or channeled bottom pipe, thence through the side tube or pipe to the header, to the suction or vacuum pump.

In the operation of sewage purification, the initial step is that of preparing the chemical reagents used in the treatment tank, which is done by adding sufficient milk of lime until the tank contains an excess of lime, for example: 100 grains calcium oxide per gallon has been found to give excellent working results, and under certain conditions it may be advantageous to add other reagents such as calcium carbonate, sand, etc., as such reagents sometimes accelerate and improve the rate of filtration. In certain cases the addition of metallic oxides and hydrates also are found to greatly aid in the precipitation in the treatment of sewage from industrial plants.

The process of screening the sewage does not require any special or detailed description in this paper, as full details and data regarding the numerous types or methods at present in use can be obtained by reference to any standard treatise on sewage disposal.

The sewage to be treated is directed into the treatment tank, first passing through any approved system of screening in order

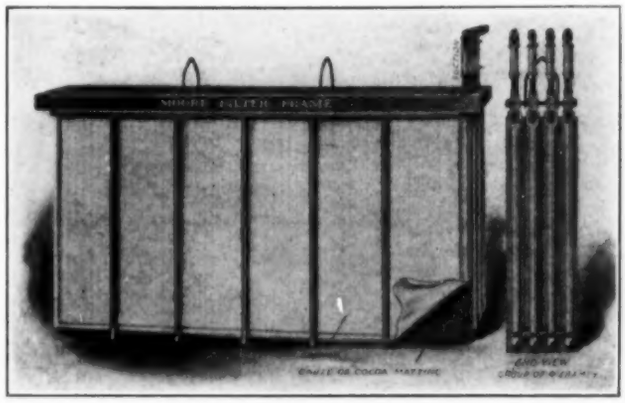


FIG. 2.—FILTER BASKET

to remove the floatage and other large bodies. The sewage on entering the treatment tank is agitated (and maintained in a state of agitation) for the reason explained, and into the treatment tank is introduced the requisite number of "baskets" of filter leaves which are submerged. Suction is then applied to the filtering mediums, whereupon a continuous flow of the agitated mixture is drawn toward the outer surfaces of the filter leaves, and on which the excess precipitant is deposited combined with the other solids in suspension. The liquid is then drawn through the film or cake of precipitant, thence through the filtering medium to the pump discharge.

By employing an excess of precipitant in the treatment tank, a film, layer or cake of the precipitant is instantaneously formed on the surface of the filtering medium, and it is found that the organic matter which heretofore it has been impossible to

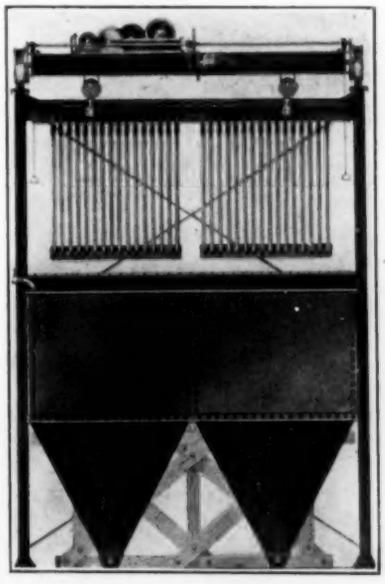


FIG. 3.—BASKET OF LEAVES IN PLACE IN TREATMENT-TANK

precipitate is thereby precipitated, and retained and combined with the other solid matter in the sewage adhering to the outer surface of the filtering medium. In practice it is found that even though this excess is present, the actual consumption of the precipitant is not greater than the amount actually required to effect the complete precipitation of the organic matter contained in the original sewage. In this simple manner the

complete precipitation of the foreign matter is effected instantaneously, resulting in the continuous discharge of a clear and harmless effluent.

The filtering operation may be continued until the deposit of solids on the surface of the filtering medium becomes so thick as to unduly interfere with the volume of liquid being drawn through, which will be indicated by the vacuum gauge and discharge from the suction pump, in which case the filtering medium or "basket" may then be raised from the treatment tank by means of the traveling overhead crane and moved to the dumping point; suction being maintained in order to hold the cake of solids on the surface of the filtering medium during this removal step. If it is desired to reduce the moisture in the solids, the "basket" may be held suspended in the air under suction before dumping.

In order to remove the cake of solids from the surface of the filtering medium, the suction is stopped and the cake is discharged therefrom by applying pressure by means of air or water within the filtering medium. After dumping or discharging the cake, the filtering medium of "basket" may then be immediately returned to the sewage treatment tank, and the filtering operation carried on indefinitely as already described.

Instead of raising and moving the filtering medium whenever it becomes coated the suction may be momentarily stopped, pressure applied and the solid matter thrown back or discharged into the treatment tank, and there become disintegrated on being subjected to the forces of agitation in the tank. After thus discharging the cake suction is again applied and the operation of filtration resumed; filtration continued until the surfaces of the medium are again sufficiently coated when the cake of solids may be discharged into the tank. This operation may be repeated until it becomes desirable to remove the accumulated solids from the treatment tank, which latter may be done in the manner already described.

If at any time during the treatment of the sewage the effluent shows any trace of organic matter, this can be at once remedied by adding fresh precipitant to the treatment tank.

Owing to there being a continuous flow of sewage into the treatment tank, which in some cases carries valuable ingredients, this latter method of operation results in the accumulation of these ingredients in a fairly concentrated and desirable condition for subsequent treatment, whereby if desired, the oils, greases, etc., can be economically recovered, and the residue used as a filler for fertilizer.

A special feature of this method of sewage purification is the destruction of harmful bacteria without the aid of any germicide. However, in exceptional cases hypochlorite will effect the complete destruction of all harmful bacteria; it is preferably added to the sewage as it enters the treatment tank.

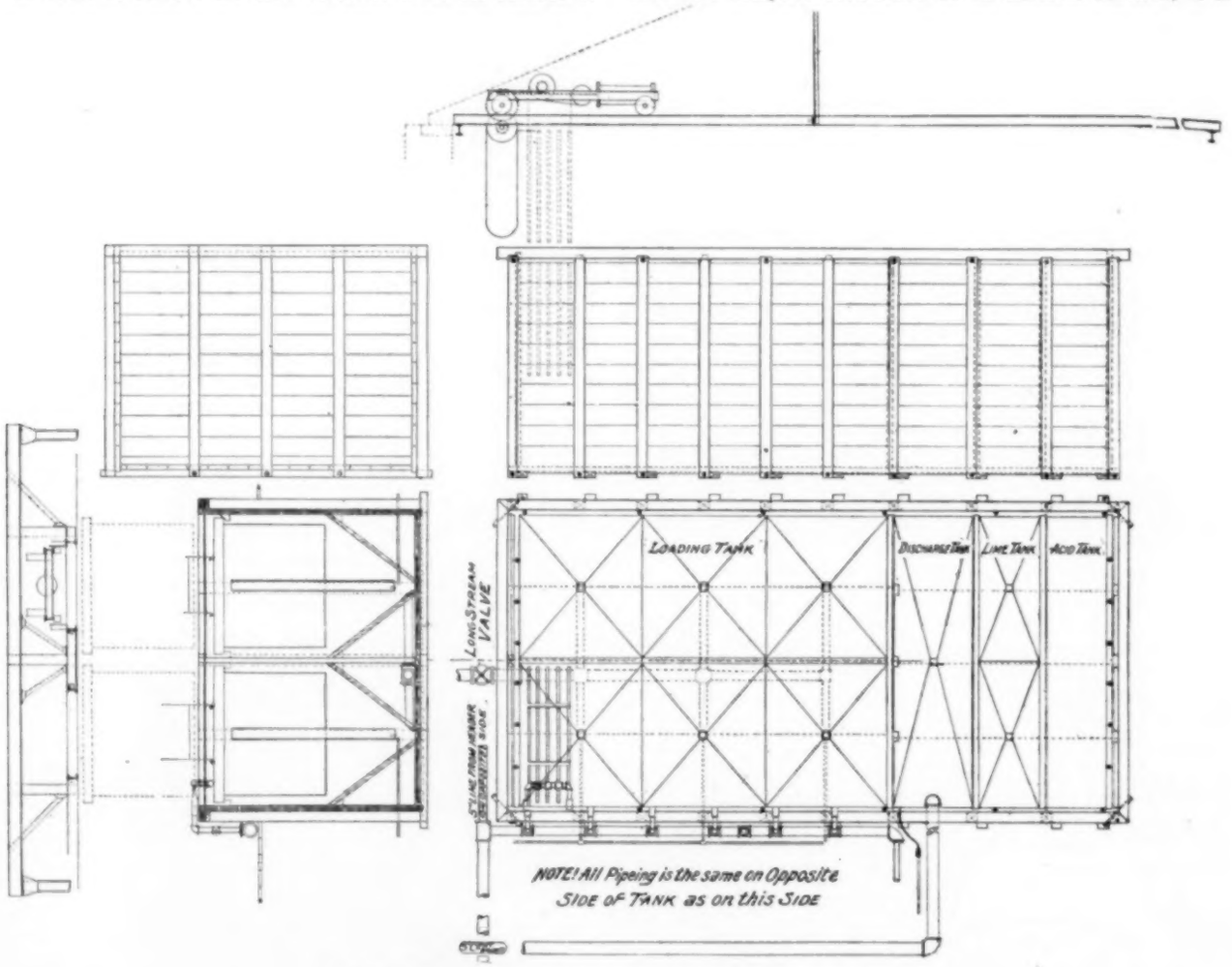

LOADING TANK
DISCHARGE TANK
LIME TANK
ACID TANK
LONG STEAM VALVE
NOTE! All Piping is the same on Opposite Side of Tank as on this Side

FIG. 4.—ARRANGEMENT OF FILTER PLANT FOR SEWAGE TREATMENT

Numerous tests of the effluent obtained by this process from sewage rich in organic matter and harmful bacteria have shown the effluent in every case to be entirely free from organic matter and harmful germs.

Another unique method of operating the process, which it is sometimes found advantageous to employ, is to have a separate loading tank into which a "basket" of the filtering medium is first immersed for the purpose of forming a film or cake of the precipitant thereon, by applying suction; when this cake has been formed on the surface of the filtering medium, the latter is then transferred and immersed in the treatment tank and the operation continued as previously described. This method is extremely effective in cases where wool scourers, tanneries, etc., add their wastes to the sewage.

Numerous demonstrations have proven that as soon as a

slight film of precipitant is formed on the surface of the filtering medium, a complete precipitation and separation of all the organic and foreign matter originally present in the sewage takes place and a clear, odorless and harmless effluent is obtained.

In operating the filters, the cake should be discharged in any of the various operating steps mentioned as soon as the vacuum gauge indicated a vacuum of 15 in., beyond which the rate of filtration rapidly diminishes.

The relative amount of moisture usually present in the discharged cake runs approximately 40 per cent, depending on the length of time the cake has been subjected to the drying action of the suction, while suspended in the air.

The chemical reagents used vary in accordance with the composition of the sewage undergoing treatment. In practice, sewage purification can be accomplished by the use of lime, copperas, alum and caustic lime mud, the latter a calcium waste product in the alkali and paper trade.

In the construction of a plant wooden tanks have been found to be suitable, thereby doing away with the expensive iron or cement tanks at present used by disposal plants.

In comparison to the ground area required for installations of the different systems in use for sewage disposal, the great advantages of this process is clearly shown by the following figures:

Sand Filtration.—This system requires an area of one acre for about 30,000 gallons per 24 hours, operating under favorable conditions.

Continuous filters, the sewage having been previouly treated either by chemical precipitation or by subsidence in settling tanks or in a septic tank, are assumed to be able to treat about 500,000 to 2,000,000 gallons per 24 hours.

The Chemproco (Chemical Process Company) system requires 240 square feet of surface area per 1,000,000 gallons per 24 hours. Besides this advantage, it is the only process delivering an effluent free from suspended matter, odorless and harmless.

The Chemproco system also possesses the following advantages over all others. It can be operated within the city limits without proving a public nuisance, and if desired it can be installed at the exits of the different sewers in cities where land values and local conditions render all other sewage disposal methods impracticable.

The process is operated by means of ordinary centrifugal pumps, driven by any desired motive power. The filtering medium with ordinary care will last from one to three years before requiring replacement.

No skilled labor is required; one man per shift can handle from one to thirty million gallons of sewage per day.

Preference is given to the recovery of the chemical reagents used in the Chemproco system from the discharged sludge. Experience has demonstrated that the regenerated reagents are not only more energetic in their precipitating qualities than the original chemical reagents, but that the rate of filtration is greatly accelerated.

The method of regeneration consists in calcining the sludge in a rotary kiln.

The operating cost of the Chemproco system ranges from $5.50 to $7.50 per million gallons of sewage.

Formastat is the trade name of specular hematite ore Fe_2O_3, which after having been purified is sold as an imperishable paint pigment. It is particularly adapted for a paint for preservation of iron, steel, metals, woodwork, or any artificial surface exposed to the elements and the influence of destructive gases. The simplest formula for using it in making up 1 gal. of paint is 8 lb. formastat, 5 lb. pure boiled linseed oil, and ¼ lb. japan dryer.

Other formulas, as well as notes on application to aluminum, gold, and copper powders, together with general rules on the use of formastat, may be found in a pamphlet just issued by the manufacturer, the Formastat Mining Company, Twenty-first and Locust Streets, St. Louis, Mo.

Method of Producing Sound Ingots

Further Details of the New Process of Sir Robert Hadfield and Results Obtained with It in France.

In our November issue, 1912 (Vol. X, p. 738), we gave an account of a paper by **Sir Robert Hadfield** before the (British) Iron and Steel Institute on his new method for producing sound ingots.

We are obliged to Sir Robert Hadfield for the following information concerning the application of his method on a large scale.

By one plan the ingots are cast in molds placed upon bogies, movable trucks, or platforms, in the position *A* shown in Fig. 1. After casting the ingots vertically on bogies, the number on each bogie being as may be found most convenient, say four or more ingots on each bogie, advantage is taken of the time which elapses during transit of the ingots from the casting pit to the stripper to maintain the upper surface of the steel in a molten condition. This is effected by a series of air pipes, for example, three in number, with jets or holes on the under surface of such pipes, placed preferably horizontally, arranged in such a manner as to cause jets of air to impinge at a suitable distance from the upper surface of the ingots. These holes or jets are made throughout the entire length of the overhead pipes, the length of such pipes being governed by the distance traversed under them by the bogies. In the figure shown the pipes are of sufficient length to extend over the tops of three rows of six bogies, each bogie containing four ingots.

One method of working is as follows:

As soon as possible after the ingots are cast, a quantity of charcoal sufficient for the purpose is placed on the top of each ingot, also a layer of insulating slag as described in the article referred to above. Although charcoal by means of the combustion effected by the heat of the molten steel delays to a certain extent the freezing of the molten steel, a blast of air applied to the charcoal generates a considerable amount of extra heat, this being of great advantage, as it helps to delay the freezing of the molten steel to such an extent that the good results before stated are effected in a manner which is impossible where such air blast is not used. The layer of slag, which may be termed an insulator, also prevents loss of heat and the charcoal is also prevented, or to a large extent so, from mixing with the steel, at any rate until too late to cause any interference with the quality of the product below the head portion.

If a series of bogies extending the length of the overhead pipes is used, the air blast may be working during the whole length of the piping, and if it should happen that only one or two bogies are in transit under the pipes it is not necessary for the air to be escaping throughout the entire length of the piping, but the air may be shut off in sections, and only allowed to escape in the section in which the bogies or ingots happen to be for the time being. Means may be provided for controlling the issue of air from each pipe to the ingots. Thus, each pipe may be formed at its lower side with a long slot or with a number of slots or apertures, and be provided with means, such as sleeves, which may be adjustable in a longitudinal or rotary manner, or in both a longitudinal and rotary manner, and by means of which the points of issue of the air to the ingot can be adjusted to suit requirements. Thus the air may issue between the adjacent ends of plain sleeves, or the sleeves may be furnished with suitably spaced nozzles, through which air can be caused to issue as required. As, however, it would be found that with normal working a continuous line of bogies would be passing underneatn the air pipes—that is to say, there would be no break between the continuity of the bogies—the combustion, which is intensified and effected by the air jets on to the charcoal, would be effectively performed and carried out whether the ingots on the bogies were moving or at rest, owing to the continuity of the air holes or jets in the pipes which exert the pressure necessary for proper combustion of the charcoal being at what-

ever position the bogies and the molds may happen to be, provided they are within the range of the overhead air pipes.

It will thus be seen that if the passage of the bogies from the casting pit until they arrive at the stripper is relatively slow, the overhead air pipes need not be so long as in the case where the passage of the bogies from the casting pit to the stripper is at a more rapid rate, for it will be evident that in the latter case the overhead pipes would have to be of greater length than if the bogies were traveling under them at a slower rate.

Approximately the time that is necessary for the blast to operate on the upper surface of the molds, that is to say, from the time they are cast until the steel is sufficiently set to avoid any danger of piping, would be in the case of rail ingots from about fifteen to fifty minutes, according to the size of the ingot, though this time is only stated approximately. Also when the rate of progress is known at which the ingots move from the casting pit to the stripper—that is, the time from which the ingots are cast until they can be safely removed from their molds—the length of the overhead pipes can be easily calculated.

Three air pipes may also be used, these pipes being arranged at such a distance from each other as will enable the three rows of jets to play upon the molten steel which forms the heads of the ingots.

The height from the track to the upper side of the runner box should be approximately the same in every case, so that the air jets have the same heating effect on every ingot.

When the bogies arrive at the stripper the ingot molds are lifted and the ingots removed from the molds in the usual manner, preferably retaining the ingots in a vertical position during the process of stripping. Considerable modification of this arrangement can be made as may be desired.

Ingots may be cast in this way with either their large or small end at the bottom, or with their large or small end at the top, whichever may be preferred, or practically parallel ingots may be produced of any size, section or shape which may be desired.

This method may be also applied to the production of castings of various types.

Another modification to effect the same object is by casting the ingot in molds upon bogies to which are attached electrically worked fans or blowers, the required electrical energy being taken from suitable overhead or underground cables. A blower of suitable type is mounted under the car at the side, or in such a convenient manner as may best suit the required purpose (see *F*, Fig. 2). As soon as the ingots are cast, the blower is put into operation, either while the car is standing still or as it moves along from the casting house. In this method a suitable supply of blast is obtained immediately after casting for each individual ingot or for a group combined on one bogie or other suitable movable or stationary casting arrangement. The blast is continued as long as required; then the car or bogie is returned for further ingots to be cast.

It might be desired also to have a combination of bogies both worked electrically and by overhead pipes.

Fig. 1 shows the method of arrangement, which can be suitably varied to suit the local conditions. Although the sectional ingot shown is with the small end down, it can, of course, if preferred be cast with the small end up.

In Fig. 1 *A* is the plan of the casting department; *B* are drying stoves for heads, and *C* is a general plan of air pipes or blast arrangements, which are also shown in elevation by *D*.

Another method would be to make the casting plant circular

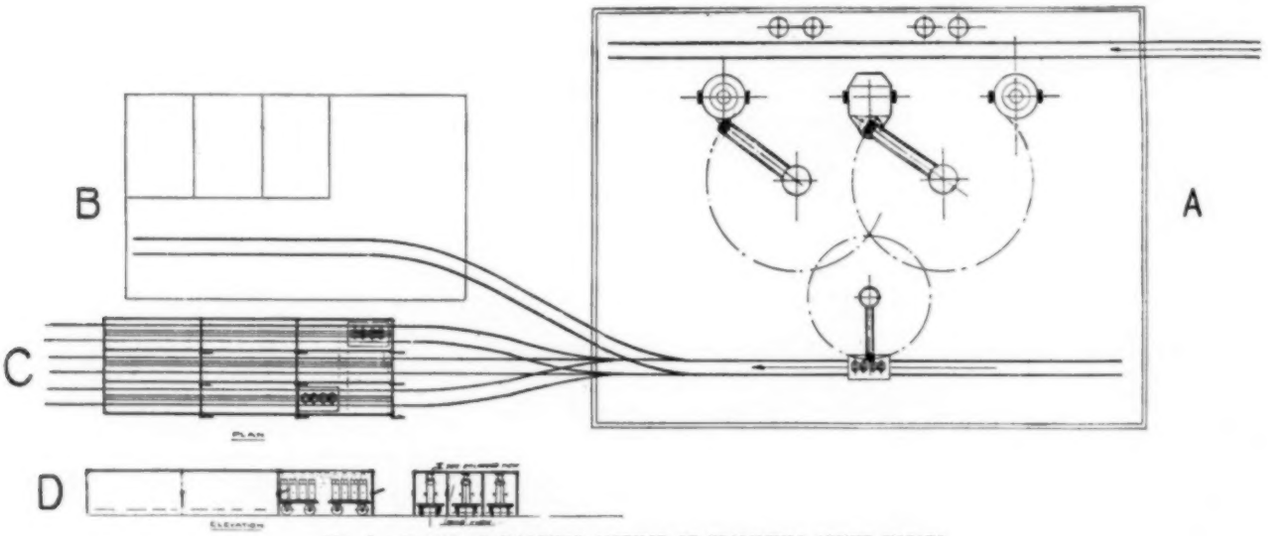


FIG. 1.—PLANS OF HADFIELD METHOD OF PRODUCING SOUND INGOTS

—that is, the rails would be in a circular form outside the casting plant, and the bogies on which the ingots were cast could go around this if it were preferred to have the plant in this form.

In Fig. 2 *E* is a section of an ingot mold standing upon the bogie top, with air pipes in position at *X*; *F* the bogie arranged with the blower attached underneath as described.

The foregoing in a general way represents the methods of obtaining the desired advantages of preferably first obtaining sound steel which would pipe, then properly feeding the steel in such a manner as to give perfectly sound ingots with very little segregation portions, so that the double advantages are obtained of sound steel combined with much less waste than ordinarily experienced. Sound rails, bars or other forms are the result, with consequent advantage and increased safety to the user.

To obtain a sound and safe rail, the steel must itself be sound and free from blowholes. This requires the use of steel which will pipe or settle. As rail steel is now made, the maker has no proper means of adequately dealing with this property of fluid steel, namely, the "piping," often very deep, produced by "piping or settling steel." He therefore tries to avoid such steel, specially as it is dangerous unless the pipe is properly dealt with and fed, for the reason that in the methods hitherto generally adopted the pipe often runs down the center of the ingot for nearly one-half or even two-thirds of its length. By the Hadfield system piping itself is avoided, proper feeding being effected. Thus ingots are obtained in which soundness is ensured, that is to say, for example, *in 10,000 ingots every one can be made sound and free from piping, blowholes and segregation.*

It is suggested that this system should be thoroughly tested by the railroad companies in the following manner: Hadfield should supply a specified number of tons of ingots, say from 10 to 100 tons, as may be desired, made under this system; these should be rolled for the railroad, making the test by the

rail mill supplying the ordinary rails. Specimen rails selected from the batch would be tested by drop test or other mechanical means, in the manner carried out for the acceptance of rails under the present specifications.

Under the Hadfield system, too, the advantage is obtained of the investigator's long experience in alloy or special steels.

It is possible to produce, quite cheaply, special steel rails showing most excellent shock-resisting qualities, high durability and other advantages, and this at little extra cost, that is, it is unnecessary to use expensive and costly steels such as high nickel, manganese or other similar types.

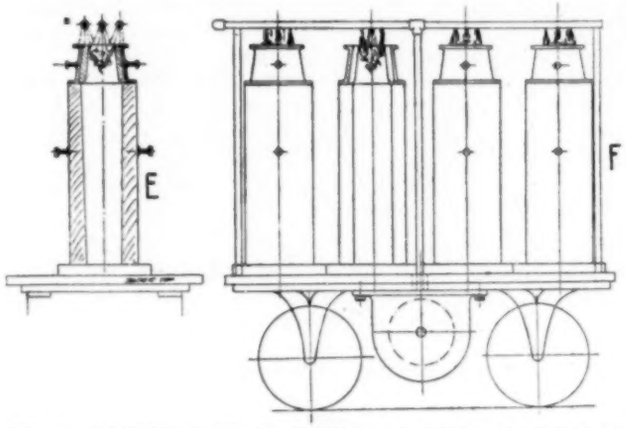


FIG. 2.—MODIFIED PLAN OF HADFIELD METHOD FOR PRODUCING SOUND INGOTS

It is estimated that by the Hadfield method the cost per ton of sound steel fusible ingots is even less than that of fusible ingots made by the ordinary method, because the extra cost of the Hadfield treatment is more than counterbalanced by the fact that the discard with the Hadfield method is only 8 per cent against 15 to 25 per cent with the ordinary method.

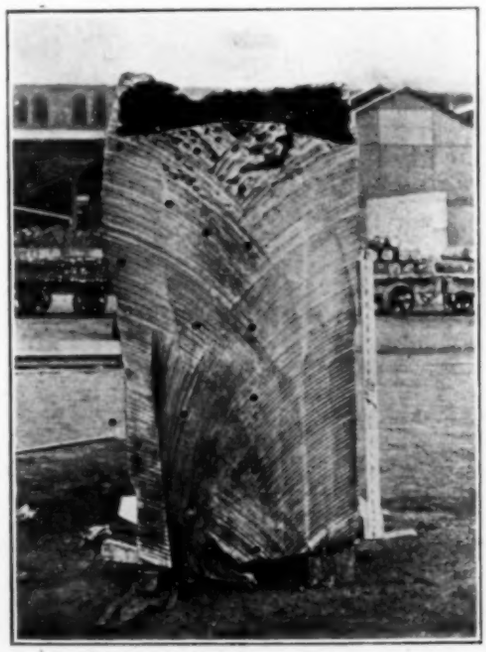


FIG. 3.—SECTION OF UPPER PORTION OF 25-TON INGOT

* * *

Quite unknown to Sir Robert Hadfield, the well-known French metallurgist, Monsieur G. Charpy, of the Cie. des Forges et Acieries de Chatillon-Commentry et Neuves-Maisons, Montluçon (Allier), after reading the Iron and Steel Institute papers on this subject, decided to test the methods for himself, and proceeded to make an ingot of comparatively large size, weighing about 25 tons. Figs. 3, 4, and 5 show the results obtained.

M. Charpy stated that the Hadfield method of feeding the upper portion of the ingot in his special manner, namely, sand head, air blast, charcoal, and insulating layer of slag, appeared to him to constitute a particularly simple and practical solution of the problem met with in steel manufacture, and to overcome the difficulties met with as regards piping, also reduce segregation and avoid the large percentage of waste material.

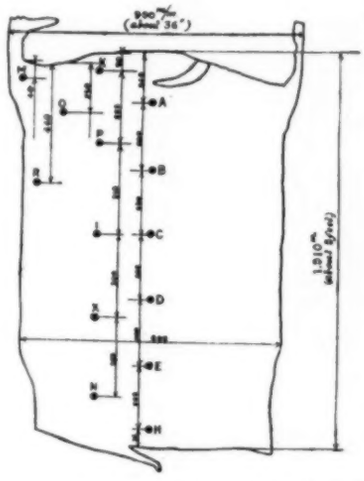


TABLE "A."

Portion Drilled	S. %	P. %
A	0.016	0.043
B	0.018	0.041
C	0.028	0.043
D	0.024	0.042
E	0.021	0.039
H	0.020	0.043
I	0.020	0.039
K	0.012	0.044
M	0.018	0.039
N	0.017	0.039
O	0.026	0.044
P	0.028	0.045
R	0.015	0.038
X	0.015	0.038

FIG. 4.—ANALYSIS OF INGOT AT DIFFERENT POINTS

Fig. 3 represents a photograph taken by M. Charpy of the upper part of an ingot weighing 25 tons. This ingot had been treated by the Hadfield method, its composition being 0.40 per cent C, 0.02 S, 0.04 P, 0.45 Mn. The material also contained a small percentage of nickel.

Fig. 3 shows the satisfactory nature of the method. The portion of the ingot shown in the photograph represents about one-fourth of its total length. M. Charpy found that in order to eliminate all faults and sponginess in the ingot in question, it was only necessary to cut off about 12 in. to 12½ in. from the upper part, in other words, about *one-twentieth of the ingot*, as against one-third which is the proportion of discard ordinarily required.

Moreover, the analyses taken of the material at different parts of the ingot showed this is free from segregation. Fig. 4 shows the parts from which the analyses given in table "A" were taken. Drillings were taken on the center line at the different parts shown, commencing at the top, marked "A," also at the other parts as lettered.

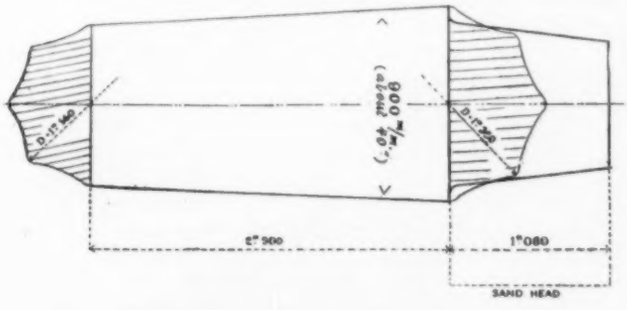


FIG. 5.—DIMENSIONS OF 25-TON INGOT

Fig. 5 shows the dimensions of the 25-ton ingot referred to. The waste and segregated material in this ingot only amounts to about 5 per cent of the total weight.

The original (British) Iron and Steel Institute paper of Sir Robert Hadfield on his process was published in our November issue, 1912, p. 738.

Some Notes on the Manufacture and Properties of Carbon Bricks.*

The resistivity of amorphous carbon against high temperatures, abrupt changes of temperatures, and not the least against chemical corrosion by ashes and slags make it especially valuable for manufacturing refractory material for smelting furnaces.

For this purpose carbon is used in form of coke which should be as much free from ashes as possible. The raw material, prior to molding, is made up in different ways. According to an older method, which is scarcely in use any more, the crushed coke is mixed with a small proportion of clay, this being in suspension in water. In the new method, now universally applied, the dried coke is crushed to grains of 1 mm. size, sieved and thoroughly mixed in the pug-mill with about 20 per cent in weight of heated tar.

The plastic mass thus prepared is filled, in successive layers, into wooden or iron molds, by taking care to create the upper surface of the last applied layer in order to secure a perfect bond between the different layers. In this operation care should be taken to fill the molds up completely, and to drive the mass into all the corners so as to obtain a brick with plain and even surfaces and sharp corners.

By following this precaution only a narrow joint will be left between adjacent surfaces of the bricks when laid aside in a wall. The drying of the wet bricks requires about two weeks, which is effected in the open air, after which they are ready to be burnt.

The bricks are then set in a producer-gas fired chamber-kiln and are enclosed in fireclay saggers. The spaces left in these saggers are then completely filled up with pulverized coke. The use of this filling is to protect the carbon of the bricks from any contact with air and combustion gases of the kiln, and to prevent combustion of the carbon.

In the average a burning temperature corresponding to Seger cone 12 is required. The tar content of the brick carbonizes during the burning and the additional carbon thus formed unites with the coke to form a strong and homogenous mass. The specific gravity of carbon bricks varies from 1.5 to 1.9; the ash contents, in average, amounts to 12 per cent.

As stated above, these carbon bricks are exclusively used in metallurgical plants. They render excellent services for lining lead melting furnaces and other metallurgical furnaces where oxidation of the molten metal is to be prevented. Special attention has been given to carbon bricks in the construction of some parts of blast furnaces, where they are used for lining both walls and bottom. According to numerous reports carbon bricks showed in this instance a most satisfactory behavior, which, as in many other instances, depends mainly upon careful manipulation and treatment.

As few and as narrow joints as possible should be made in laying carbon bricks, otherwise the molten metal would enter the joints and cause loosening of the lining.

A mortar made up of pulverized coke with 20 per cent of good fireclay has been successfully used. This mixture, after being ground to a minute powder, is stirred up with pure water, *i. e.*, which should be free of any soluble salts, to the consistency of a slip and this just before being used as mortar. It is essential for guaranteeing durability of the masonry to allow the same to dry slowly and thoroughly.

After all the water contained both in mortar and bricks is expelled, the furnace then may be put in service, otherwise mortar as well as bricks will be dislocated by a too sudden evaporation of the water. The solidity of the carbon brick masonry requires the application of a special and proper outside shell extending over the bosh and the hearth portions of the furnace.

The opinions about unlimited solidity of carbon bricks in metallurgical furnace practice differ, according to observers and circumstances. As to Dr. Ing. C. Geiger, in No. 41 of *Stahl und Eisen*, 1912, carbon bricks showed especially good results in the production of high-carbon gray iron. Again, the fitness of this kind of bricks for foundry iron has repeatedly been confirmed; also successful results have been obtained with them in connection with Thomas iron.

These favorable reports have, however, been opposed by the testimony of other metallurgists who observed evident failures in several instances, so that the carbon bricks soon disappeared when in contact with so-called white pig iron and Thomas iron. A complete explanation of these failures has not yet been given, so far as the actual observations go. According to Mr. v. Schlippenbach this is probably due to the greater indirect reduction of the iron oxides by the carbon or that the iron with normally low carbon percentage readily combines with that of the carbon lining.

In order to elucidate this question further it would be a valuable undertaking for manufacturers of refractories as well as for metallurgists if accurate observations and systematic tests would be made and published.

*Trans'ated from the *Thonind. Zeit.*, by Leon V. Schleich.

Notes

The order in which the stamps drop in the Homestake mills is 1-3-5-2-4, or what is the same thing, 1-4-2-5-3. This order has been tested with other variations, such as 1-5-3-2-4 = 1-3-4-2-5, and has been found to give a slightly greater daily tonnage.

The extent to which gold penetrates copper plates in amalgamation has been investigated by Clark and Sharwood (Bulletin 98, Inst. Min. & Met.), who found that beyond a depth of 0.005 in. from the face of the plate nearly all the value lay in dents and pinholes. The percentage of gold found in layers next the surface, totalling about 1/64 inch, was 98 per cent. The value of gold contained in a square foot of outside plate was $0.31; of a chuck-block plate, $1.11.

Potash explorations in Nevada and Nebraska have disclosed deposits of potential value in both states. In Nevada the Silver Peak marsh was drilled and found to yield salts containing as much as 3.5 per cent K_2O. Certain shallow lakes in the sand hills of western Nebraska also contain potash in solution as well as in the surface of the lake beds.

Developed ore in the mines of the main reef series of the Witwatersrand is estimated at from 100,000,000 to 110,000,000 tons. At the present crushing capacity of Rand mills this ore constitutes a reserve sufficient to last for three years.

Protecting Exposed Metal Work in Battery Rooms.—No metal work in a battery room, especially over the cells, should be exposed to the action of the acid fumes and gases. The structural iron work of the building can be very well protected by encasing it with expanded metal work upon which a coating of cement plaster is placed. This if kept well painted with a good lead paint will prove a very satisfactory way of protecting all structural metal work. Pipes and small portions of metal work can be protected by sheet lead, or if they are not in too close proximity to the cells can be protected sufficiently by frequently cleaning and painting with an acid resisting paint such as Hydrex preservative paint. This paint is very thick and heavy, and forms a strong, heavy protective coating, and does not contain any coal tar to corrode the metal. It is claimed to be acid, gas, and sulphur fume-proof. The battery rooms in all new electric sub-stations of the New York Central Railroad are painted with this preservative paint. One great danger of exposed iron work in a battery room if it extends over the battery, is that the sulphate of iron formed by the action of the fumes may fall into the cells and impair the purity of the electrolyte, thereby seriously damaging the plates.

The **Biddle Bulletin** is the title of a new trade publication issued by the Biddle Hardware Company, of Philadelphia, Pa., to give information on new developments in the Monel metal market.

Ore Sampling Without Machinery

A Series of Instructive Illustrations Explaining the Essential Feature of Ore Sampling. By Jesse Scobey

CORRECT sampling is the basis of ore valuation; an assay can represent only the proportionate value of the sample tested. These two propositions are recognized as fundamental by competent technical men, and yet occasional evidence is found which indicates that these principles are violated even by those who should know better, not to mention those whose lack of training and experience lead them into costly errors. Perhaps the self-evident nature of the requirements of correct sampling is one reason why comparatively little attention has been paid to the subject in technical literature. Hence no apology is required for reiterating some facts which cannot be too strongly borne in mind. An assay is worthless unless the sample is representative, as many a man has learned with regret.

FIG. 1.—A PILE OF 400 LB. OF ORE

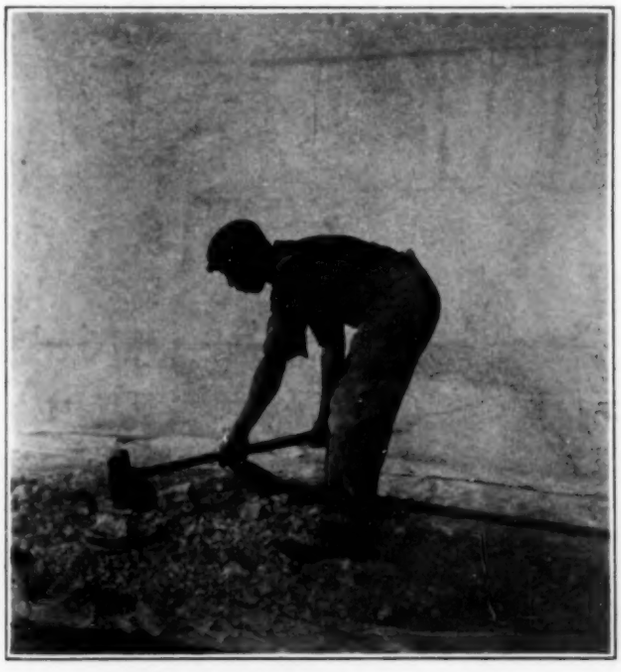


FIG. 2.—HAMMER CRUSHING

It frequently happens that laymen who are interested in mines, or who desire to investigate mining propositions in a tentative way, resort to the practice of taking their own samples for assay. The results may be disappointing or highly encouraging, but are worthless unless the sampling has been performed properly. If the ultimate result is unsatisfactory, it is customary to claim a discrepancy in the assay without realizing that the error possibly lies in the sampling. This is an old subject, well understood by some, but may be repeated for the benefit of those not familiar with the technique of mining.

In order to appreciate the relation of assaying to correct sampling, let us consider briefly the conditions surrounding the former operation. In assaying, the results are reported in ounces of gold or silver per ton of ore; that is, a ton of the ore in question would contain one or several ounces of gold or silver. With silver worth 64 cents per ounce, an assay of 10 oz. silver per ton means that a ton of such ore would contain silver to the value of $6.40. If a ton of this ore should be mixed with the proper amount of suitable fluxes, and smelted in a sufficiently large furnace, it would yield exactly 10 oz. of silver, about the size of six silver dollars. This would be a perfect assay; but manifestly it is impossible to work on so large a scale, and the practice of assaying limits the amount of ore used to an assay-ton, which is a quantity slightly more than 1 oz. It is, then, essential that this small amount of ore should be exactly representative of the ton. By delicate balances the actual amount of silver smelted from the amount of ore used is weighed, and by proportion the amount per ton is calculated. The whole secret in the proper valuation of a ton of ore is, then, simply to get a correct sample of it, weighing not more than a few ounces.

Sampling without machinery[1] requires not only manual labor, but the exercise of care in order to approximate the accurate results which can be obtained with mechanical appliances. If a ton of ore can be sent to a testing or sampling works equipped with crushers and samplers, the work is simple indeed. Many mine operators, engineers and others engaged in mining have not these facilities, and do not care to incur the expense of sending ore to the testing works. In order to accomplish the same result by hand-sampling there need be only a full realization of the fact that the ore must be broken finer and finer at each successive stage of the process, as the remaining sample becomes smaller.

The illustrations herewith will convey the idea better than a lengthy description. The pictures show the successive steps in sampling a lot of crude ore.

Fig. 1 shows a pile of 400 lb. of ore. It was broken from a

[1]Brunton has described and illustrated the possible errors in coning and quartering. *Transactions* A. I. M. E., Vol XL, p. 567.

vein, the value of which is to be determined by assay. When a representative sample is desired, it is inadvisable to start with less than 400 lb. of ore.

Fig. 2. Using a sheet canvas, an anvil or heavy piece of iron and a heavy hammer, break each piece of ore to less than fist-size. Scatter the pieces well over the canvas to be sure that all are broken.

FIG. 3—SHOVELING INTO A CONE

Fig. 3. With a square-pointed shovel throw all the ore into a central pile or cone, dropping each shovelful precisely in the center. This is a precaution that must be observed in order to distribute the coarse and fine ore uniformly on the pile.

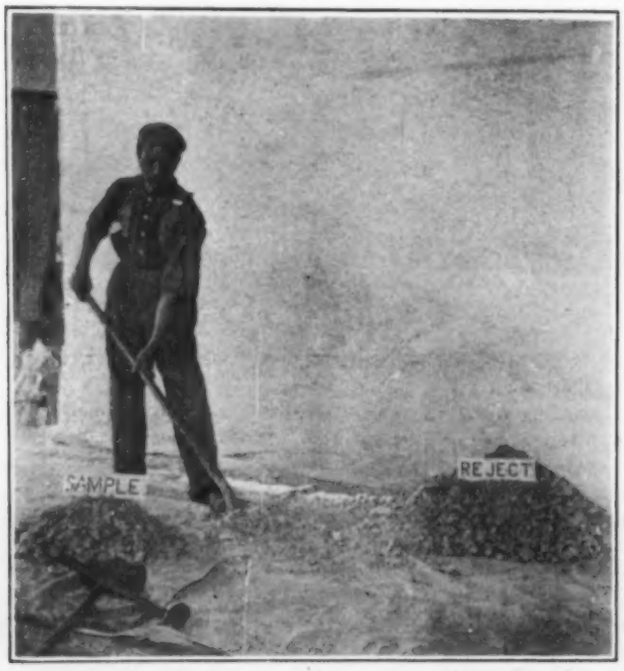


FIG. 4.—SAMPLE PILE OF 100 LB. AND REJECT PILE

Fig. 4. By working around the pile with the shovel, draw the center to the sides in order to mix evenly the fine and coarse particles. The cone is thus transformed into a flat pile or bed several inches thick. Then throw one shovelful to the "sample" pile and three shovelfuls to the "reject" pile, making a sample which shall be one-fourth the size of the original pile. Each piece of ore in the "sample' should be one-fourth or less of its original size.

FIG. 5.—CRUSHING SAMPLE WITH HAMMER TO NUT SIZE

Fig. 5. We now have about 100 lb. in the sample. Take a hammer and again break each piece of rock to less than nut-size. Thoroughly spread and mix this portion as before.

Fig. 6. The sample is again carefully coned, and flattened by tamping down the top. This gives a flat cake which can be marked into quarters by means of a board and shovel.

FIG. 6.—FLAT CAKE

Fig. 7. By shovelling away opposite quarters we leave a sample weighing about 50 lb., while the 50 lb. of "reject" can be discarded.

Fig. 8. The same operation described under Fig. 5 must now be repeated, breaking each piece to pea-size or smaller, spreading the ore over the canvas to be sure than all pieces are broken.

Fig. 9. Shovel the sample into a cone again, carefully cleaning the canvas with a broom so as to be sure that no fine ore is lost.

Fig. 10. Flatten the cone, mark into quarters, and with a small fire-shovel remove oposite quarters. Remix the remaining ore; cone and quarter again. The sample will now weigh about 10 or 12½ lb.

Fig. 11. This sample must now be ground on a bucking-board until fine enough to pass a 10-mesh screen (openings about 1/20 in.). Pour this fine ore through a divider, shown at the left on the table; reject one portion, and again divide the other. One portion of this last division will weigh about 2 or 3 lb.

Fig. 12. Repeat the grinding operation shown in Fig. 11 until the sample will pass an 80-mesh screen. Divide the sample twice as before, when the final portion will weigh about 8 oz. and will fairly represent the original 400 lb. This is a safe and sane sample for the assayer.

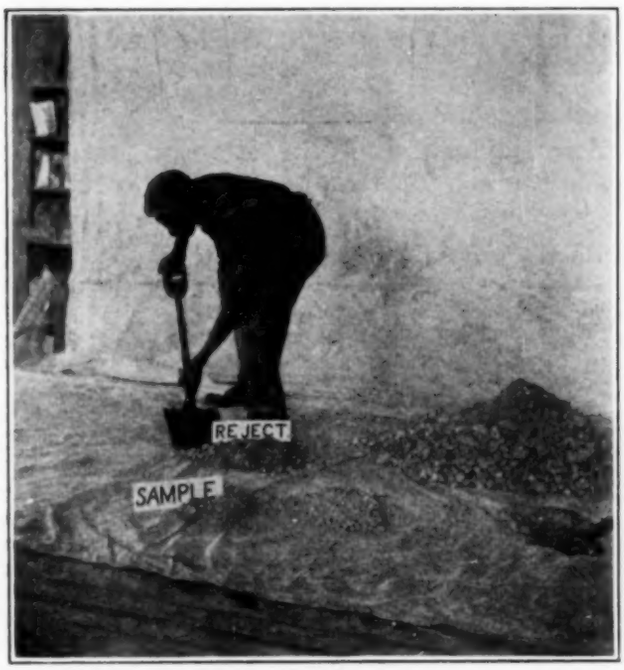


FIG. 7.—REDUCING SAMPLE TO 50 LB

FIG. 9.—CONING AGAIN

FIG. 8.—BREAKING TO PEA SIZE

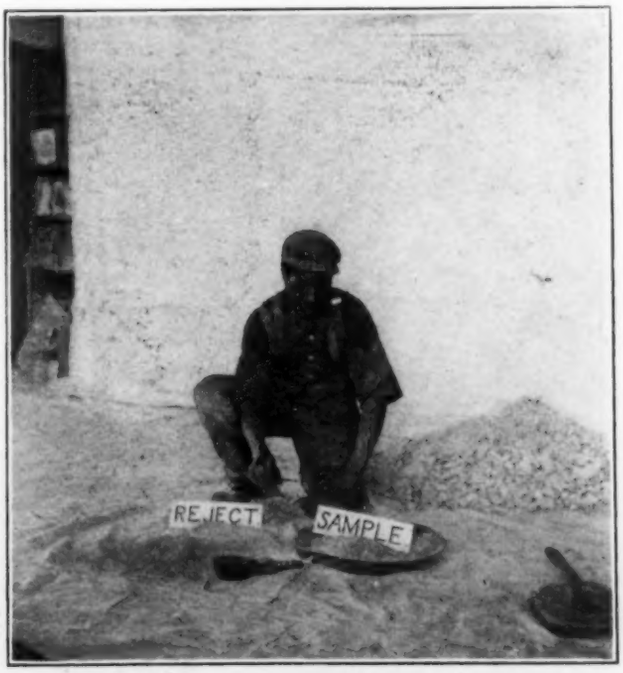


FIG. 10.—REDUCING SAMPLE TO 10 OR 12½ LB

The procedure just described may be subject to modification for different grades of ore, richer ores requiring finer subdivision in the successive steps so that the whole mass may be more intimately mixed. The following table shows the maximum size of particle that should exist in the different portions

as the quantity retained for the sample decreases. Column A refers to a medium-grade ore; column B to a high-grade ore, and column C to a very rich ore.

FIG. 11.—REDUCING SAMPLE TO 2 OR 3 LBS.

Quantity of ore to be sampled.	A Size.	B Size.	C Size.
100 tons to 10 tons	5¼ in.	3 in.	2½ in.
10 tons to 1 ton	2½ in.	1½ in.	1¼ in.
2000 lb. to 200 lb.	1 in.	¾ in.	½ in.
200 lb. to 5 lb.	5/16 in.	3/16 in.	5/32 in.
5 lb. to 8 oz.	1/32 in. or 16-mesh screen	1/64 in. or 30-mesh screen	1/164 in. or 80-mesh screen

FIG. 12.—REDUCING SAMPLE TO 8 OUNCES

Consideration of the foregoing will show that the cost of conscientious and accurate sampling is greater than is sometimes conceded to be a reasonable charge. Engineers and laymen should recognize the importance of a properly taken sample and should insist upon it; otherwise there will be a misconception of the value of the ore, and dissatisfaction when it is shipped to the testing works, mill or smelter.

A "mill test," so-called by the old-time prospector or miner, is nothing more than the shipment of about 400 lb. of ore to an assayer who, with proper facilities, crushes and samples the lot to obtain a representative portion for assay. A common charge for this work is from $1 to $5. Anyone can do it in the field by following the above procedure, realizing that time, labor, and care are essential.

The Henry E. Wood Ore Testing Company, Denver, Col.

An Application of the Electric Resistance Furnace to the Determination of Oxygen in Iron and Steel

By R. H. McMillen

The fact that iron and steel always contains more or less oxygen has long been known, and about thirty years ago Ledebur[1] called attention to it and gave a method for its determination. It is only recently, however, that the requirements in the manufacture of high-grade steels have become so exacting that the determination of oxygen in steel and other materials has come to be one of the routine determinations required of a steel laboratory.

The Ledebur method, which is well known, consists in heating the sample of iron or steel in nitrogen to remove all moisture without oxidizing it, then reducing the oxides at a red heat by hydrogen and absorbing and weighing the resultant water. Cushman[2] has shown that the drying of the sample in nitrogen is unnecessary, his results being but slightly higher than those by the original method. When used with electric resistance furnaces, this method is very satisfactory for the determination of oxygen in iron and steel, tungsten[3], and other non-volatile metals. Even this method, however, will fail to show all the oxygen in metals containing oxides of silicon, vanadium, titanium, and other elements whose oxides are not reduced below 950 deg. C.[4]

The following modification of the Ledebur method has been found to give most satisfactory results:

Apparatus.

The apparatus consists of two electric, resistance furnaces, such as are employed in many steel laboratories for combustion carbon determinations and capable of maintaining a temperature of 950 deg. C.

They are designated as No. 1 and No. 2 in Fig. 1. Both furnaces are equipped with heavy walled, fused quartz tubes ⅞ in. inside diameter by 24 in. long. The function of furnace No. 1 is to heat the sample under investigation, while that of No. 2 is to heat the hydrogen so that it may combine with any oxygen that may be carried over from the hydrogen generator. Several spirals of platinum gauze are placed in the quartz tube of this furnace.

The quartz tubes of these furnaces are connected in the rear by a U tube (not shown in the illustration) having close fitting glass stop-cocks. This U tube is filled with phosphorus pentoxides opened by small glass beads. The phosphorus pentoxide absorbs any water which may be formed in tube of furnace No. 2, and insures absolutely dry hydrogen to pass over the sample in furnace No. 1. The front end of the quartz tube in No. 2 furnace is connected to the drying and purifying train leading from a hydrogen generator.

No. 3 contains small pieces of pumice stone saturated with concentrated sulphuric acid, No. 4 soda lime, No. 5 stick potassium hydrate, No. 6 50 per cent solution potassium hydrate, No.

[1]Sauerstoffbestimmung im schmiedbaren Eisen. Stahl und Eisen, Vol. 2, page 193.

[2]The Determination of Oxygen in Iron and Steel. Journal Ind. and Eng. Chem., Vol. 3, page 372.

[3]Tungsten powder often contains a rather large percentage of oxides. Some commercial samples investigated by the writer recently have shown an oxygen content corresponding to 12% WO_3. It is probable, however, that the whole of the oxygen is not combined with the tungsten.

[4]See The Determination of Oxygen in Iron and Steel by Reduction in an Electric Vacuum Furnace by W. H. Walker and W. A. Patrick. Met. and Chem. Eng'g, Vol. 10, p. 629. Original Communications of Eighth Interrat. Congress of Applied Chemistry, Vol 21, p. 139.

7 25 per cent solution of pyrogallol made alkaline with potassium hydrate.

Hydrogen is generated in a sixty-four ounce Kipp apparatus by the action of chemically pure hydrochloric acid on pure mossy zinc.

The water formed by reduction of oxides in the sample is absorbed in U tube No. 9 of same construction as No. 8, and also filled with phosphorus pentoxide opened with small glass beads. A guard tube, No. 10, is attached to No. 9 and contains concentrated sulphuric acid. A small wash bottle of Drexel form is used for this purpose. Porcelain boats of sufficient size to hold at least twenty-five grams of the sample are employed.

Preparation of Sample

Great care must be taken in preparing the samples so that they be free from rust or foreign oxides. In the case of iron or steel samples both the fine and coarse drillings are rejected, only those between twenty and thirty mesh being used. These

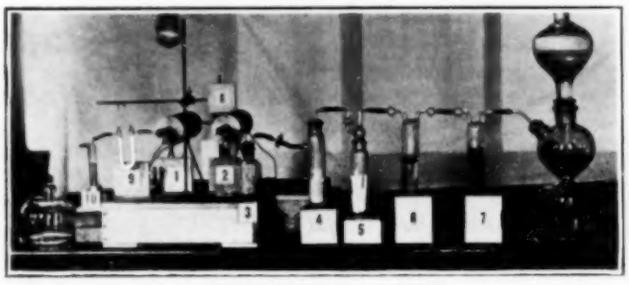


FIG. 1.—APPARATUS FOR DETERMINATION OF OXYGEN IN IRON AND STEEL BY A MODIFIED LEDEBUR METHOD

are dried for at least one hour over concentrated sulphuric acid before using. Samples of tungsten powders are dried to a constant weight in the drying oven at a temperature of 105 deg. C.

Procedure

Twenty-five grams of the prepared drillings are weighed into the dried porcelain boat and placed in tube of furnace No. 1. Connection is made to weighed U tube, No. 9, through which, just previous to drying for fifteen minutes and to weighing, hydrogen has been passed for ten minutes. Guard tube No. 10 is connected. Hydrogen is allowed to pass through the whole apparatus at a rapid rate for fifteen minutes. For the first run it is advisable to allow the hydrogen to sweep through the whole apparatus for thirty minutes to insure complete expulsion of oxygen from the train and tubes. The train and quartz tube of furnace No. 2 can be kept constantly filled with hydrogen by closing cocks of U tubes No. 8 whenever the flow of hydrogen is interrupted.

The electric current is turned on and continued for one hour after the maximum temperature has been reached. During this time the flow of hydrogen is cut down to about seventy bubbles per minute, this rate being maintained until U tube No. 9 is removed. At the end of the hour the crrent is turned off and furnaces allowed to cool, accelerating the cooling with a blast of compressed air. When the quartz tubes in the furnaces show no visible redness, cocks of U tube No. 9 are closed and a pinch cock is inserted over the rubber tube connecting U tube No. 9 to the quartz tube of furnace. In this manner oxygen is kept from the heated tube thereby avoiding danger of explosion. U tube No. 9 is disconnected and carefully wiped with soft dry cloth then dessicated over concentrated sulphuric acid for fifteen minutes and finally quickly weighed. Weight of water, after deducting blank, multiplied by 0.8888 divided by 25 equals oxygen.

A blank should be run frequently, adhering to all details as to time of heating furnaces, dessicating U tube, etc. Usually the blank found varies between 0.0015 and 0.0025 gram.

For samples of tungsten powder the same procedure is carried out except that a smaller sample is taken varying from one to ten grams according to amount of oxygen present.

The following table gives results on several samples in duplicate by the above described procedure:

No.		K Car.	Mn.	Sul.	Phos.	Sil.	O.	Duplicate, O.
1	Crucible steel.....	1.15	.31	.018	.011	.22	.039	.037
2	Crucible steel.....	1.17	.31	.015	.010	.22	.035	.035
3	Crucible steel.....	1.14	.33	.016	.009	.21	.044	.045
4	*Basic open-hearth steel	.07	.06	.019	.008	.08	.113	.115
5	Basic open-hearth steel.	.08	.22	.016	.008	.01	.079	.072
6	Swedish wrought iron..	.06	.17	.019	.012	.02	.345	.353
7	Domestic wrought iron.	.69	trace	.009	.007	.06	.069	.076
8	Domestic wrought iron.	.73	trace	.009	.007	.06	.090	.089
9	Acid open-hearth steel..	.36	.69	.040	.046	.03	.043	.042
10	Bessemer steel	.46	.72	.041	.095	.09	.058	.060
11	Tungsten powder	...	...	....	....	...	2.57	2.57
13	Tungsten powder	...	...	....	....	...	1.37	1.34
14	Tungsten powder	...	...	....	....	...	.55	.56
15	Tungsten powder	...	...	....	....	...	1.02	1.05

Numbers 1, 2 and 3 were three ingots made under as nearly the same conditions as possible. It is not intended that the above table should be typical as to the oxygen content that exists in the different classes of steel. In many samples of crucible steel it is much lower than those cited.

*This sample fractured badly in rolling.

Crescent Laboratory,
Crucible Steel Company of America.

Swedish Methods of Packing Ferrosilicon

Two Swedish manufacturers of ferrosilicon export their product to the United States. Their methods of packing the product have been secured by Consul Stuart J. Fuller, Gottenborg, and transmitted to the United States Bureau of Commerce and Labor. The method of the Gullspangs Elektrokemiska Aktiebolag are as follows:

"For packing we principally use iron-bound wooden cases in two sizes, one (for 50 per cent ferrosilicon) containing about 130 kilos (287 lb.) and one (for 75 per cent) holding about 160 kilos (353 lb.). The boxes have always been unlined and were made in the beginning of unrabbeted 5/8-in. stock, but since last year we have employed rabbeted stock, as the loss of contents in transit was found to be too great with unrabbeted boards. Water-tight packing being required for Germany, we pack goods for that country in second-hand kerosene barrels; these are, of course, both water and gas tight, but no fault has been found with them. On all our very latest shipments we have, at the request of foreign sellers, begun to pack ferrosilicon in sheet-metal cylinders containing about 170 kilos (375 lb.), and have made four holes of 7 mm. (0.276 in.) diameter in the top to provide against excessive pressure in the cylinders.

"It will be seen from the foregoing that the regulations in force are different for different countries (*e. g.*, for transport on some English railways each package must have three 1-in. holes to permit the escape of any gases that may form). In our opinion, the dangers connected with the transportation of ferrosilicon can never be entirely avoided until uniform international regulations are adopted. In this connection it should be noted that danger is present only when the material has a silicon content between 35 and 65 per cent; under and over these proportions ferrosilicon is much more stable. So far as we are informed, accidents have never happened except with ferrosilicon of about 50 per cent silicon content. If, as we hope, an international regulation regarding packing and transportation of high percentage ferrosilicon can be established, regard should be had for the last-mentioned fact, and different regulations adopted for 25 per cent, 50 per cent, and 70 per cent goods or those of higher percentages.

Four Styles of Package Used by Another Firm

"The Aktiebolaget Heroults Elektriska Stal thus describes in detail its methods of packing ferrosilicon:

"Until recently we used wooden barrels as containers for ferrosilicon. These barrels consisted of:

"(*a*) Old oil barrels and tar barrels, etc., holding about 500 kilos (1100 lb.) of 50 per cent ferrosilicon. These barrels we would describe as tight with exception of the cover, which is made of rough boards laid edge to edge without rabbets and held together by two laths. Across the cover are then nailed

two pieces of hoop iron, the ends of which are turned down and nailed to the sides of the barrel.

"(*b*) Wooden barrels, which hold about 700 kilos (1545 lb.), shaped as cylinders and made of 1-in. rough and unrabbeted boards, which have the edges cut aslant so that they fit or overlap each other in the sides of the barrel. The bottom and the head are made as described under (*a*).

"(*c*) The last few months we have used barrels taking about 300 kilos (660 lb.) and made in the same way as those described under (*b*), but of ¾-in. boards instead of 1-in.

"(*d*) Barrels holding about 300 kilos (660 lb.) and consisting of cylinders of 0.6-mm. (0.0236-in.) sheet iron. The rolled or folded seam is reinforced with rivets. The head and bottom are made of wood, as described under (*b*), but of rough boards, and are placed so far inside the cylinder that the rims of the same can be turned over the bottom and cover about ¼ in. Head and bottom are fastened by nails driven through the wall of the cylinder and into the wood.

"We use only barrels, which can be rolled and therefore are more convenient to handle when moved than would be the case with another form of package—boxes, for instance. Besides this, the round form is stronger with the same thickness of walls.

Advantages and Disadvantages.

"With reference to the packing according to (*a*) and (*b*), these packages proved too heavy to handle with ease, and therefore we changed to packing (*c*). As, however, the packing (*c*) costs more for a certain quantity of ferrosilicon than the packings (*a*) and (*b*) and also increases the weight of the tare and consequently the freight that has to be paid per ton of iron, we have during the last few weeks partly adopted the packing (*d*).

"The forms of packing (*a*), (*b*) and (*c*) have this disadvantage, that when the packages have been stored for some time the wood has dried and shrunk, causing cracks between the staves as well as between the staves and the head or bottom, and these cracks have been large enough to let some of the ferrosilicon powder fall out. Some ferrosilicon has always a tendency to fall apart into powder or dust, and such powder is also formed when the packages are handled. Therefore, when the barrels are rolled, chiefly in transit, some of the pulverized ferrosilicon can fall out through the cracks, causing disagreeable controversies between seller and purchaser concerning the net weight.

"We consider that this inconvenience is most easily avoided by using the packing (*d*), for in this the walls do not allow any powdered ferrosilicon to escape, and the rims of the cylinder, turned over the edges of head and bottom, also prevent loss of powder between the wood and the metal wall of the cylinder. According to our opinion, this advantage is obtained with packing (*d*) without preventing ample ventilation in the barrels. Should it, contrary to our supposition, be shown that this ventilation is insufficient, holes can easily be made in the center of head and bottom, and these holes can be covered with wire-cloth, perforated metal sheets, or strong bagging."

Tungsten-Molybdenum Thermocouple.—In Dr. E. F. Northrup's article in the January issue, page 45, the sentence beginning in the eighth line of the second column should read: "At 1000 deg. C. (instead of 100 deg. C.) the oxidation is negligible, etc."

Cement Floor.—"The best hardening preparation for a cement floor is composed of equal parts of care, cement, and water used when the floor is built," states Leonard C. Wason, president of the Aberthaw Construction Company, of Boston, in a recent paper. "Various advertised products have been tried out, and there is considerable divergence of opinion. Certainly none of them have had uniform success, as could hardly be expected, under varying degrees of intelligence in their handling. So far as our experience goes we do not know of anything btter than a floor made with properly selected stone and cement, laid intelligently and properly protected."

Specifications for Open-Hearth Steel Blooms, Billets and Slabs for Forging Purposes.

The Association of American Steel Manufacturers has just issued a set of "Standard Specifications for Open-Hearth Steel Blooms, Billets, and Slabs for Forging Purposes."

The need for standard requirements governing the chemical and other properties for forging billets has been apparent for some time and the new specification may be expected to be used widely in this field. A feature that is distinctly new is the table of allowable variations on check analysis of carbon, manganese, and other elements. In giving this table out for general use the Association of American Steel Manufacturers is taking a bold step toward standardization. Mr. A. A. Stevenson is the president and Mr. Jesse J. Shuman, care of Jones & Laughlin Steel Company, Pittsburgh, Pa., is the secretary of the association.

The new specifications are as follows:

I. Manufacture.

1. *Process.*—The steel shall be made by the open-hearth process.

2. *Discard.*—A sufficient discard shall be made from the top of each ingot to secure freedom from injurious piping and undue segregation.

II. Chemical Properties and Tests.

3. *Chemical Composition.*—The steel shall conform to the following requirements as to chemical composition:

Element.	Class.	Least Range to Be Specified.	Allowable Variation on Check Analysis Outside of Range Specified. Under.	Over.
Carbon	Up to .10, .11 or .12	...	...	.02
	.10 to .25	.05	.02	.05
	.26 to .60	.10	.02	.05
	.61 to .90	.15	.02	.08
Manganese	Up to .60	.20	.05	.05
	.61 and over	.30	.05	.05
		Least Maximum to Be Specified.		
Phosphorus	.....	.040	...	.010
Sulphur	.....	.045	...	.010

4. *Class.*—The class shall be determined by the upper limit specified for carbon and manganese.

5. *Ladle Analyses.*—To determine whether the material conforms to the requirements specified in section 3, an analysis shall be made by the manufacturer from a test ingot taken during the pouring of each melt. If requested, a copy of this analysis shall be given to the purchaser or his representative.

6. *Check Analyses.*—Check analyses may be made by the purchaser in accordance with the standard methods of sampling for check analysis adopted by the Association of American Steel Manufacturers,[1] and these analyses shall conform to the requirements specified in section 3.

III. Workmanship and Finish.

7. *Chipping.*—Chipping shall be done in such a manner as not to cause any imperfections when the billets, blooms and slabs are properly forged.

8. *Finish.*—Billets, blooms and slabs shall be free from all injurious defects.

IV. Marking.

9. *Marking.*—The melt number shall be legibly stamped on each billet, bloom and slab.

V. Inspection and Rejection.

10. *Inspection.*—(a) The inspector, representing the purchaser, shall have free entry at all times while work on the contract of the purchaser is being performed, to all parts of the manufacturer's works which concern the manufacture of the material ordered. The manufacturer shall afford the inspector, free of cost, all reasonable facilities to satisfy him that the material is being furnished in accordance with these specifications.

(b) The purchaser may make the tests to govern the accept-

[1] See this journal, Vol. X, p. 701 (October, 1912).

ance or rejection of material in his own laboratory or elsewhere. Such tests, however, shall be made at the expense of the purchaser.

(c) All tests and inspection shall be so conducted as not to interfere unnecessarily with the operation of the works.

11. *Rejection.*—Billets, blooms and slabs which show injurious defects while being finished by the purchaser may be rejected, and the manufacturer shall be notified.

12. *Rehearing.*—Samples tested in accordance with section 10 (b) which represent rejected material, shall be preserved for one month from the date of the test report. In case of dissatisfaction with the results of the tests, the manufacturer may make claim for a rehearing within that time.

Recent Advances in the Spray Process for the Production of Metallic Coatings

By M. U. Schoop

In spite of the extraordinary simplicity of the principle which underlies the spray process for the production of metallic coatings, which I described in an article in this journal in July, 1910 (vol. VIII, p. 404), careful experiments extending over several years were necessary to transform the original idea of the invention into a practically successful process.

In order to be practically successful, the apparatus must be capable of being started or stopped at any time within a few minutes and the necessary materials must be easily procurable anywhere. Further, the apparatus must be easily movable so that even objects of large dimensions, wherever they may be located, can receive a cheap and durable metallic coating.

This goal has now been reached. Coatings of all metals, of the easily fusible tin and lead, as well as of copper, iron, platinum, can be made with the spray process.

The first experiments were made with a Flobert rifle. Experiments with small cannons followed whereby powdered lead or tin was sprayed. In some of the experiments the charge of ground metal in the cannon was carefully heated and melted by means of an alcohol lamp. Though these experiments were rather primitive, they showed, nevertheless, that the problem could be solved in two ways. Either molten metal could be sprayed or metallic powder could be used if only the powdered metallic particles were given a large kinetic energy. For this reason the first patents alluded expressly to the use of either fluid metal or metallic powder (Swiss patent 49,278, of November 26, 1909).

Spraying Liquid Metal

It is evidently difficult to design an apparatus in which metal is molten and sprayed so that it can be easily and quickly put into operation. It is even more difficult to make it movable, while with a stationary apparatus the application of the process would be considerably limited.

It is not difficult to build apparatus of this kind on a small scale so that large molten baths are avoided. But such apparatus involve essential and inherent difficulties, of which one of the most troublesome is the tendency of the molten metal to alloy with the crucible and the spray nozzle. The formation of alloys seems to be aided considerably if the molten bath is under pressure and if high temperatures are used. With easily fusible metals, crucibles of soft steel can be used, while with aluminium, brass, and copper only graphite or carbon fulfills to some extent the requirements. The spray nozzle cannot be made of copper nor of metal.

We succeeded in overcoming these defects by employing as container for the molten metal a closed armored crucible, to the interior of which either a pressure or a vacuum may be applied at will by simply turning a handle. If the molten bath is put under pressure the molten metal is ejected in form of a capillary uniform filament, while when a partial vacuum is applied the ejection of metal stops. This pneumatic device has the advantages that the apparatus can be started or stopped at any time. My French patent 441,100 contains a diagram which illustrates the operation of this apparatus.

This apparatus was the final result of a large number of experiments and undoubtedly represented a considerable advance since it was now possible to spray and deposit metals of any melting point. These pneumatic melting crucibles, however, are not particularly easy to handle or to transport.

In this article it is not possible to describe in detail the experiments which have been made in my Zürich laboratory with this melting crucible. It may only be stated that the conditions of operation, especially the amount of pressure and vacuum in the crucible, the design of the spray nozzle, the pressure and the temperature of the metal to be sprayed, etc., must be different for different metals. For every metal the application of the process must be worked out separately.

A characteristic feature of the metallic coatings which are obtained by spraying liquid metal seems to be that the metal increases in hardness and loses in ductility, and according to our experiments it does not matter much whether compressed air or steam, or hydrogen, or nitrogen gas is used. It might have been thought that the phenomenon is due to oxidation, but the same results are obtained if non-oxidizing gases are employed so that any oxidation of the metal from the spray nozzle to the surface to be coated is avoided.

Spraying Metallic Powder.

In a series of further experiments metallic powder or metallic dust was sprayed with great force. In this case the process may be aided by heating the metallic powder or the gas or the surface to be coated. If, however, the kinetic energy of the metallic particles is large enough, no flame or other method of heating is required with certain metals. This surprising result is probably due to the fact that the metallic particles shot upon the surface with great speed (great pressure) get heated momentarily and are thereby welded together.

In the apparatus described in German patents 252,565 and 253,510 the metallic powder is blown in an adjustable quantity by means of compressed air to the spray nozzle and is then blown through a concentrically arranged blow lamp flame. With lead, tin, and zinc, compressed air and illuminating gas are used. With metals which are not so easily fusible oxygen must be employed.

In this process it is important to avoid overheating as this would cause evaporation of the metal. On the other hand, if the temperature is insufficient or not uniform the different particles do not weld together into a uniform and intimate coating.

Very promising results have been obtained so far, especially with tin and zinc coatings, as described in the *Chemiker Zeitung*, 1911, No. 155, p. 1434. It may be mentioned that the new zinc coating process has been introduced on a large scale in several factories in Belgium and France and also in the French Navy.

Coating with lead by this process is also successful if non-oxidized lead powder is used. This condition, however, is not easily fulfilled in practice since lead powder oxidizes when in contact with air.

The Latest Development of the Spray Process.

An observation which was made incidentally in the spring 1911, led finally to a new method which is different in principle from our former methods. The fundamental idea is to melt from a metallic strip or wire only such a small quantity of metal as is to be sprayed at any moment. Fig. 1 illustrates the principle; *e* is the surface to be coated; *a* is the metal from which the coating is to be made. It is placed within the guide cylinder *b* and is being pushed uniformly forward so that its lower end is molten off by means of the flame *c*.

The drops which form in rapid succession are finely subdivided by means of the "transportation wind" blown through the pipes *d* and are thereby shot upon the surface *e* where they weld together and form a beautiful metallic coating. The thickness of the coating is practically proportional to the time of the spray operation. The gas pipe for the flame and the pipe for the "transportation wind" may also be arranged concentrically, as shown in Fig. 2.

The pressure to be used and the chemical nature and temperature of the flame depend primarily upon the nature of the metal to be sprayed and the same is true for various other factors like the speed with which the metal to be sprayed is pushed through the guiding cylinder, further, the quantity, temperature, and pressure of the "transportation wind," the distance of the spray nozzle from the surface to be coated, etc.

It is well known that with the oxyacetylene blow pipe and with the electric arc temperatures of 2500 deg. or over may be

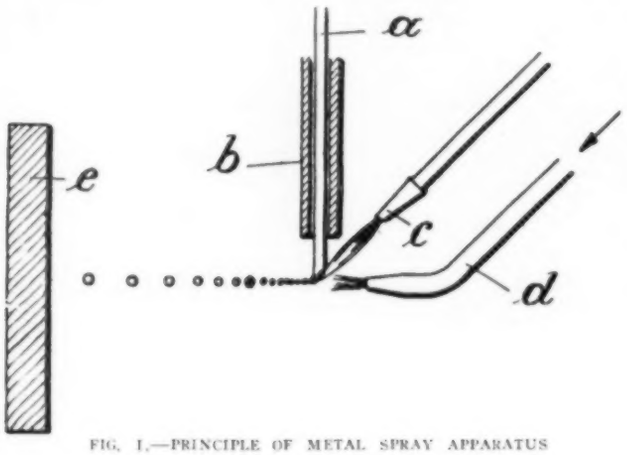


FIG. 1.—PRINCIPLE OF METAL SPRAY APPARATUS

produced. The application of this process involves neither theoretical nor practical difficulties in the production of coatings of brass, copper, nickel, iron, gold, and even platinum, and it permits the production of beautiful coatings free from oxide on *any surface whatsoever*. The italics are used with purpose to avoid any misunderstanding and to indicate that even inflammable substances, like wood, paper, celluloid, woven fabrics, and even explosives can be coated by this process. As an example, it may be said that a bunch of safety matches taken from its box and brought without any further preparation into a spray of brass was covered within two minutes on all sides with a brass coating without the heads of the matches being ignited.

Fabrics of every kind, including fine Brussels laces, can be coated with copper after they have been spread on a board. The Army department of a large country makes experiments at present with balloon material which we coated in Zürich on one side with a brass film of 0.002 millimeter (0.08 mil.) thickness.

The surprising fact that inflammable or fusible materials can be coated by this new process is probably explained by the considerable reduction of the temperature of the very finely divided particles caused by the sudden expansion of the com-

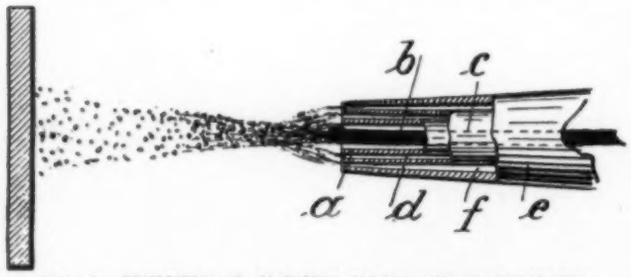


FIG. 2.—PRINCIPLE OF MODIFIED METAL SPRAY APPARATUS

pressed air in the moment of spraying. Moreover, the first thin film formed acts later on as a protecting layer.

I do not intend to discuss the theory of the process any further, but one fundamental difference between this new process and the older process using metallic powder may be pointed out. In the new process, the temperature of the blow lamp flame is hardly much different from the melting point of the metal, since the spray takes place immediately after melting. On the other hand, in the old process in which metallic powder was used, the spray coming out of the spray nozzle consists of an intimate mixture of metallic powder and air or gas and each metallic particle is surrounded by an insulating film of air which is, of course, highly heated so that the heat efficiency is necessarily reduced.

Other advantages of the new process are that there are no more losses of metal and that the blow lamp can be easily adjusted so that the melting and spraying process takes place in the reducing zone of the flame.

Fig. 3 is a photograph of a "metal spray pistol" which is based on the new principle. Its design is the outcome of experiments, which were continually carried out for more than a year and a half in which my associate of many years, Mr. F. Herkenrath, participated. *a* is the wire of the metal to be sprayed; *b* are two guide rolls which are geared to the compressed air turbine *c*. By means of the handle *d* the supply of the gas as well as of the compressed air is cut off.

The compressed air supplied to the apparatus first sets the small turbine *c* in motion (30,000 to 35,000 revolutions per minute) by means of which the wire is pushed with an adjustable and uniform speed into the spray nozzle. From the turbine the compressed air passes in form of a concentric cylinder to the opening of the spray nozzle and aids the blow flame in subdividing and spraying the metal.

When certain metals like iron and copper are sprayed there is a clearly discernible smell of ozone. We have not yet found a certain explation of its formation.

Fig. 4 shows the use of the metal spray pistol in practical operation. It is suitable for making coatings of brass, copper,

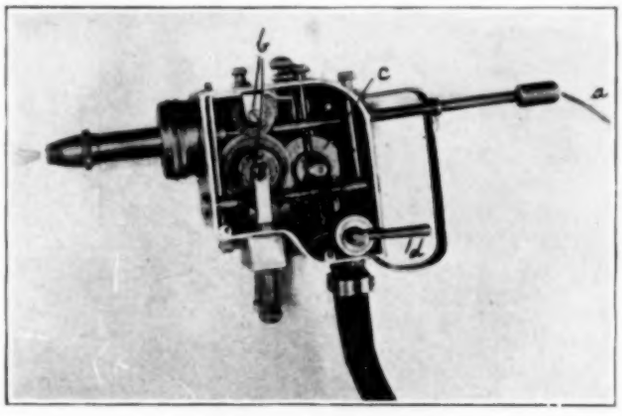


FIG. 3.—METAL SPRAY PISTOL

steel, etc., and is operated with hydrogen, oxygen, and compressed air. The box on the floor contains the coils of wire.

The metal spray pistol is particularly suitable in all cases where complicated surfaces or surfaces with large dimensions and in a somewhat remote position are to be coated. For instance, it is only a question of time when ships of the navy and of the mercantile marine will be coated with an adherent layer of copper. Experts consider the solution of this problem to be of eminent importance for the whole ship building industry and a practical solution of this problem has been sought as long as ships have been in existence.

Radiators for heating houses when coated with brass look good and also have a better heating efficiency than radiators coated as usual with a heat-insulating paint. In the electrical industry the process is suitable for many different purposes, as in the manufacture of resistors of all kinds, for making carbon conductive, for coating contact points in order to reduce the resistance, etc.

The many fields in which the process can be used and will be used, might best be illustrated by enumerating some of the things which have been sent to me in the course of time to Zürich to experiment with. It is a real museum which has nothing to compare with and which comprises brass-coated doll heads, sharpnel igniters, balloon material, metallized paper for transatlantic transportation, machine parts coated inside with

zinc or lead, beer kegs coated with tin, linen screens coated with aluminium for moving picture shows, cables coated with zinc, art products in which the metallic coating produces a special decorative effect, etc. It is no exaggeration to say

FIG. 4.—APPLICATION OF METAL SPRAY PISTOL.

that every second day something new comes up, although it is also true that the inquiries received are often senseless and that valuable suggestions of new and useful applications of the process are the exception rather than the rule.

Zürich-Höngg,
Switzerland.

The metallurgical sources of gold recovery in 1911, according to figures just given out by the United States Geological Survey, were as follows: Dredging, 10.9 per cent; other placer operations, 13.1 per cent; amalgamation, 23.9 per cent; cyanidation, 26.1 per cent; chlorination, 3.8 per cent; smelting, 22 per cent. These proportions probably will not change greatly for 1912, although the recovery by chlorination may be entirely eliminated, and the recovery by cyanidation may increase. Dredging also will increase its output.

The filtration of finely divided precipitate may be accomplished by the aid of a thin film of collodion, according to Zsigmondy, Wilke-Dorfurt and Galecke, in the *Berichte*. To prepare these films a 6 per cent collodion solution is diluted with twice its volume of ether and five times its volume of absolute alcohol, and poured in a thin film over a glass plate. When the ether has evaporated so that the collodion is no longer sticky the plate is plunged into water. After 10 or 15 minutes the film can be separated from the glass, and can be preserved under water. To prepare the filter, first place an ordinary ashless filter paper on the filter-funnel, and then cover the paper with a piece of the collodion film. See that the film covers the paper and is pressed against the sides of the glass funnel. Use in the usual way with a water-jet pump.

The Technical Analysis of Ferrovanadium and Its Products

The Determination of Aluminium in Ferrovanadium

By Wm. W. Clark

The writer will give a series of articles on the determination of the different constituents of ferrovanadium and its allied products. The methods given are in daily use, and have proven accurate, and rapid enough for routine work.

The determination of aluminium in ferrovanadium is the first, the method given having been in use for about three years. It is fairly rapid in comparison with other aluminium determinations, taking about 3 hours for a single determination, while a single operator will run 12 in an 8-hour day.

A number of methods were taken up and discarded, those that at first sight looked the best adapted for the material being given with the objection to it.

The precipitation of the aluminium from the neutral or acetic acid solution as phosphate with thiosulphate of sodium, and the precipitation with organic precipitants were discarded as useless, as vanadium precipitated with the aluminium in each case, and under all conditions. The precipitation of the iron with sodium hydrate, and the determination of the aluminium in the filtrate is a long, tedious operation. The iron forms a very bulky precipitate, from which the aluminium is separated with difficulty, taking several reprecipitations, and a large bulk of wash water. The method while accurate takes about 12 hours for a single determination.

The fusion of the alloy with sodium peroxide, and the determination of the aluminium in an aliquot portion of the filtered solution, gives low results, as some aluminium is always held out of solution by absorption in the iron precipitate, and consequently an accurately measured part of the aluminium is not taken with the aliquot portion.

The method finally accepted as being accurate under all conditions, and rapid enough for a busy laboratory is as follows:

Dissolve 0.50 grams of the finely powdered material in 40 cc. strong hydrochloric acid and 5 cc. strong nitric acid, evaporate to a skim, add 20 cc. strong hydrochloric acid, transfer to a separatory funnel, washing out the beaker with a small amount of dilute hydrochloric acid (2 parts acid to 1 part water). Add 75 cc. ether, cork, and shake for 2 minutes. Allow the two layers to separate, and draw off the lower portion into a 400 cc. beaker, being careful to get the drainings from the sides of the funnel. Evaporate the dissolved ether, being careful not to ignite it, add 1 gram sodium chlorate, boil 1 minute, dilute to about 300 cc. with boiling water, and add sufficient excess of sodium hydrate solution to insure all vanadium and aluminium passing into solution. Add bromine if nickel is present until the precipitate turns black, boil 2 minutes, then add 25 cc. hydrogen peroxide, boil 2 minutes, and filter on a close filter using a platinum cone to prevent the paper from breaking, and washing the precipitate with hot water. Boil the filtrate and if any precipitate forms filter again on a close hard filter. Acidify the filtrate with dilute hydrochloric acid, add 25 cc. hydrogen peroxide, then ammonia until the solution just smells faintly of it, dilute to about 800 cc., and boil until the solution no longer smells of ammonia. Filter on a loose filter, washing the precipitate with hot water until the washings are free from chlorides, ignite in a weighed platinum crucible at a low heat, finally blasting for a few minutes. Cool, add a few drops of sulphuric acid, 10 cc. of hydrofluoric acid and evaporate to dryness to remove any silica and ignite over a blast lamp until all sulphates are decomposed. Weigh and subtract from this weight any blank of alumina in the reagents. The resulting weight of Al_2O_3 multiplied by 106.06 gives the percentage of aluminium in the alloy.

The upper layer of ether left in the separatory funnel is distilled in an electric still, the ether vapor condensed and used again with very little loss.

The silica could be removed from the solution at the start by evaporation to dryness with hydrochloric acid, and subsequent solution in hydrochloric acid, and filtering,, but a number of

tests have shown that the removal of the silica in the crucible by means of hydrofluoric acid, gives the same results, saves considerable time, and removes any blank of silica from the reagents.

The lower portion drawn off from the separatory funnel should be a deep blue or green color, and if brown, as it sometimes is from the presence of nitric acid, must be evaporated again with hydrochloric acid, and the ether separation repeated with fresh ether.

The precipitate from the soda precipitation is small, allowing the aluminium to be washed out very easily. It contains all the nickel, manganese, and a small portion of the iron. The bromine is first added in this precipitation to make the precipitate of nickel granular, thus saving considerable time filtering, and the peroxide is added later to precipitate any manganese in the solution. The nickel can be determined from this precipitate, by dissolving it in hydrochloric acid, precipitating the iron with ammonia, and determining the nickel in the filtrate by titration with silver nitrate and potassium cyanide.

When oxidizing with hydrogen peroxide in the final precipitation an excess must be used, as this is the main point of the method. Vanadium will precipitate with the aluminium turning it a light yellow, if the peroxide is not in excess. This yellow color can be removed by adding more peroxide and ammonia and again boiling. The precipitate of aluminium hydroxide filters very rapidly, and will contain no vanadium when washed free from chlorides with hot water.

If the alloy contains an appreciable amount of phosphorus, the solution in the platinum crucible, after removal of the hydrofluoric acid, is diluted, sodium ammonium phosphate solution added, and the aluminium precipitated from the almost neutralized solution with sodium thiosulphate, filtered, washed, ignited at a low temperature in a porcelain crucible, and weighed as $AlPO_4$, which, after the subtraction of the blank, is multiplied by 44.38, giving the percentage of the aluminium in the alloy direct.

Following are some results on a synthetic solution of the approximate analysis of the ferrovanadium solution to which a known amount of aluminium was added in the form of aluminium potassium sulphate, and on a standard ferrovanadium.

Al. added.	Synthetic solution Al. recovered.	Standard Ferrovanadium Aluminium.
1.00%	1.02%	0.82%
	1.00	0.78
	0.98	0.82
	1.02	0.83
	0.99	0.79
0.50	0.49	0.79
	0.48	0.81
	0.52	0.83
	0.53	0.79
	0.50	0.81

American Vanadium Co.,
Bridgeville, Pa.

The only important manufacturer of pig iron in Mexico is the Cia. Fundidora de Fierro y Acero, of Monterey, Nuevo Leon. In 1911 this company produced 71,337 tons of pig iron, being an increase over 1910 of 26,246 tons. Imports of iron into Mexico during the fiscal year 1910-11 were made from Great Britain, United States, Germany and China. The duty assessed on foreign pig iron by the Mexican government is 0.02 peso per gross kilo, equivalent to about 0.45 cent per avoirdupois pound; on wrought iron and steel in ingots, 2.5 pesos per 100 gross kilos, or about 0.56 cent per pound. In addition to this duty a surtax of 5 per cent is assessable under the provisions of the budget of June 3, 1912.

The price of standard topographic maps issued by the United States Geological Survey was increased on January 1 from 5 cents each to 10 cents each, wholesale lots being sold at 6 cents when the order amounts to $3 or more.

The Manufacture of Chilled Iron Car Wheels

A New Titanium-Boron Ferro-Alloy and an Apparatus for Testing Car Wheels

By Dr. Frederick C. Weber

In making a plain chilled iron car wheel from the usual mixture of pig iron, generally foundry No. 3, old car wheels, and steel and malleable iron scrap, there are always a small number of wheels which are found to be of very inferior quality, when subjected to testing and inspection.

A wheel should stand a thermal test of not less than two minutes before cracking. The drop test of dropping a weight onto the wheel is practically worthless, for there is no strain on the wheel flange during service which is similar to this drop test strain. The flange test should be a direct pressure strain on the flange and should show a direct resistance directly proportional to the weight of the car wheel and the load it is intended to carry.

No standards embodying the above are established yet. How many tons of strain there are on the flange of a wheel in service is variable. It depends on the velocity of the train, the degree of the track's curve, the width of the gaps at the rail joints and at the frogs and crossings, and on the way the car is loaded.

When making direct pressure flange tests the loaded car load weight is to be subtracted from the direct pressure breaking strain or this strain is to be compensated for by adjusting a vertical pressure for each weight car wheel. This can be done in a flange testing machine, of suitable construction.

The above factors collectively determine how much strength must be possessed by a wheel flange to be safe during service. I have arbitrarily placed the required strengths at the following figures based on such data as I have been able to gather. There are four car wheels which can be considered as being standard sizes, having a weight of 625, 675, 725 and 800 pounds respectively. The thickness of the flanges is proportional to the wheel's weight or better, proportional to the car load strain. The first weight is that of a wheel for cars carrying loads up to 30 tons, the second for cars carrying 30 to 40 tons, the third for cars carrying 40 to 50 tons, and the fourth for extra heavy cars of 50 tons capacity and over.

The breaking flange strengths should be taken irrespective of the varying load bearing upon the tread of the wheel. The first wheel should have a minimum flange strength before breaking of not less than 55 tons, the second of 65 tons, the third of 75 tons, the fourth of 85 tons. All of these strengths should be for between the brackets. For over the brackets the strengths should be 5 tons higher in each case.

The testing machine must be adjusted to exert a vertical load pressure of 12, 15, 18 and 20 tons on the several weight wheels to represent the loaded car pressure on the tread. And the flanges must show the above resistances for flange strengths before breaking with these load pressures bearing on the tread of the tested wheel. All wheels should, of course, average higher for all weights for all lots.

The above figures for strengths are purely arbitrary, but reasonable and fair and can be met in all foundry practice now. These figures should be the minimum for wheels to pass inspection.

Car wheels which are made from the above mentioned mixture will stand a flange test as above, all the way from 35 tons to 60 tons for test lot averages, and as high as 90 or even 100 tons for an occasional wheel. But quite a number creep in which are as low as 25 tons. It is this marked unevenness which is the most serious feature of a chilled iron car wheel. It is the low test wheel which gives out in service and which it is the aim to eliminate.

Under a freight car using a four-wheel truck there is a distribution of weight per wheel of practically one-eighth of the car's weight loaded or unloaded. In railroad operating practice this figures out as there being practically one-third of the total weight for the empty cars when figuring loaded train

weights. It gives a down pressure of practically 20 tons per wheel due to jolting on the tread of the wheel for the standard unit 50-ton loaded freight car, for the smaller cars less.

The factors to consider when calculating strengths required for flanges are as given above plus the centrifugal force in rounding curves and the pounding of the wheels over the gaps in the rails at the rail joints and frogs and crossings.

Iron which is of low grade and of uneven composition is more or less weak at all times. It is this uneven iron which causes so wide a range in the wheel's strength. Then there are the brown spot flaws in the throat between the tread and the flange which when present means a broken wheel every time in service.

This brown spot flaw I consider to be an incipient check due to viscosity of the molten iron at the time of pouring and it not filling the mold solidly. This incipient check at the moment of forming becomes oxidized to Fe_3O_4 because the iron is red hot. During service of the wheel the check becomes enlarged to a well defined crack and this enlargement becomes covered with Fe_2O_3.

Then the chilled iron car wheel is subject to the formation of what are technically known as "bones." These bones I consider to be of two distinct kinds. First, bones of a segregation of slags, and second, a bone of a hard spot of steel. This steel bone hard spot comes from the steel scrap fed into the cupola with the mixtures, and the steel not becoming fully melted and incorporated with the rest of the metal in the cupola. The segregation bones of slag get into the wheel by slag flowing through the spout of the pouring ladle and by the segregation of slags within the body of the metal.

These two bones can be avoided first by exercising care to keep the work in hand by keeping slag from flowing into the pouring ladles from the bull ladle and second by scavenging or rather cleansing the molten iron.

Here a change in foundry practice is clearly indicated. The bull ladle must not only be mounted on trunnions, but it must be so constructed that it can be emptied from below either by having a vertically placed skimmer or be tapped below so that no slag will flow into the pouring ladles from that on top of the metal in the bull ladle. There must be some slag floating on the molten metal to cover it in the ladles to prevent oxidation and nitrogen absorption, but in the pouring ladles a film at once forms acting as a protection and then the pouring ladles are soon emptied. That will eliminate the plain slag bone.

The other, the segregation slag bone, is perfectly eliminated by means of a ternary alloy of iron, titanium, and boron.

The steel hard spot bone must be kept out by using no scrap steel in large pieces and then the scrap must not be covered with dirt or clay which will form a crust over the scrap and prevent it from melting and mixing into the mass of metal in the cupola.

It is at the frogs and crossings where the bones play havoc, for the softer metal at the sides of the harder metal of the bones becomes crowded past the bones by the cold flow of the softer metal by the pounding and then it is only a question of time when the iron having become tired, breaks.

The strain on the flange varies through a wide range with the train in motion. The track is never dead level. When rounding curves the outer rail being higher equalizes some but the train speeds are never the same, so consequently the speedier the train the more pressure on the flange.

Then there is the factor of the temperature to consider, for instance, when the thermometer reaches 40 below zero with the attendant effect of making the iron cold short.

Making a chilled iron car wheel to meet these various requirements is not exactly a boy's job. The essentials are a tread and flange far harder than the rail to minimize abrasion and having a toughness needed to withstand the pressure produced by centrifugal force on the flange, in rounding and pounding around curves at all speeds and temperatures.

It can be done! The iron's composition and handling as influenced by the various processes to which it is subjected, are the factors which must be considered in making a wheel which is to meet the severe calls made upon it when in service.

The very first factor for improvement is to empty the bull ladle from below to eliminate the plain slag bone; and not neutralize in the pouring ladles any added cleansing or scavenging compounds or as the foundrymen say dope.

No steel or malleable scrap should be added to the mixture which is in any way dirty. As a matter of safety all steel or malleable scrap should be cleaned in a rattle-box first. This will surely eliminate the steel bone.

The coke and limestone and the pig iron used in the cupola must be analyzed so that the right amount and kind of limestone flux can be added to the mixture so as to make a subsilicate slag. To correct any thickness of the resulting slags from using old wheels of uncertain composition some fluorspar, usually about 1 per cent, must be added to the mixture along with the coke and limestone.

But now comes the vital determining factor of causing the iron to have the essential quality of a fine, even, live, homogeneous grain with no interference with the irons taking the chill and additionally having imparted that strength which goes with purer iron while making it more liquid in the pouring and through these absolutely to eliminate the brown spot flaw, the segregation bones, and so eliminate the low test wheel.

An alloy—or rather my alloy, for I was the first to make it—composed of iron, titanium, and boron imparts the above essential qualities. The alloy contains Fe74, Ti12, B8, AlSi, etc., 6 per cent. This alloy combines with the occluded nitrogen which produces brittleness, it being fluxed out. The boron fluxes out the slags from within the molten metal and incidentally brings up some phosphorus and sulphur. While the trifle of aluminium in the alloy reduces whatever oxides of iron and manganese may be in the iron which along with the slags in the iron makes the iron viscous or pasty.

A curious action of the boron is that at the temperature of molten iron the boron determines that some of the graphitic carbon enters into combination, it becoming combined carbon. While at the temperature of molten steel, all excess of boron over that required to flux out slags is converted to B_2C_2, and this acts to throw carbon out of combination, making it graphitic.

The iron treated with this alloy has a live appearance. Its color is of a lighter gray, finer grained. It is homogeneous throughout and the chill looks more fibrous and steely. During all testing of wheels treated with this alloy so far not a single brown spot flaw nor a bone has been found nor has a low test wheel appeared. None were found on flange testing as low as the minimum demanded, while a number were foud breaking as high as 110 and 117 tons. And that for medium weight wheels. No. 800 lb. wheels were made or tested.

To use this scavenging alloy means that the foundry methods and practice must be adapted to its requirements. The alloy being a fluxing alloy demands that it be thrown into the bottom of the pouring ladles, the ladles being red hot and empty or nearly so of the previously poured metal. The iron from the bull ladle flowing onto the alloy mixes it in and the fluxed out impurities of the treated metal rising to the surface promptly furnish the required protective film of slag.

The slags formed during melting the mixture and flowing from the cupola cover the molten metal in the bull ladle; if they should flow from there into the pouring ladles and there come into contact with the cleansing alloy, they would at once flux between themselves and the alloy would be wasted.

The alloy is not neutral to the slags like a metallic alloy, as, for instance, ferrochromium. The cleansing alloy will flux out the impurities from the iron only when the iron and the alloy are in shape for the alloy to act on the impurities in the iron. The aim is to cleanse and scavenge the iron and not to flux any floating slags.

The alloy will when correctly used flux with the impurities of the iron into which it is incorporated up to its saturation point. Of course, the cleaner the iron the less alloy will be required to obtain a given result. But the very fact that it scavenges the molten iron by a true fluxing action means the production of a far more uniform iron.

All the way from ½ lb. to 5 lb. per wheel were used. In some as little as ½ lb. was required to show a good improvement in the iron. Even this small amount of the alloy eliminates the brown spot flaw.

Boron was found in the treated iron when 3 lb. and over per wheel was used. The 3 lb. per wheel were the strongest wheels.

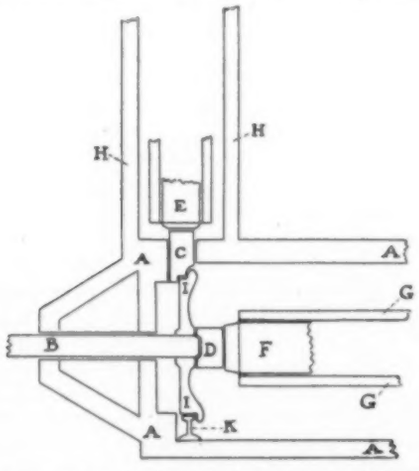
It has been found in practice that the alloy must be thrown into the bottom of the pouring ladles in fine powder, not coarser than will pass a 12-mesh sieve. It dissolves very readily in the molten iron and is best thrown into the pouring ladles as fast as they are fully emptied from pouring a wheel. The alloy then has the necessary time for action from one pouring to the next.

The increased strength of the iron is that increase which is the result of its being cleaner, more homogeneous, and of finer, even grain, and the improvement is such that the cleansed metal is very decidedly better than non-cleansed metal. This alloy is the best scavenger so far used.

The testing of a wheel for its flange strength must be done with a proper regard to its being at least approximately correct. No such thing as putting a wheel into a frame and putting a hydraulic ram at the hub by guess at centering will show anything one way or another.

The frame must be a rectangle or a rhombus with its greater diameter placed horizontally. Its upper side must have an inserted vertical pressure block.

Sliding up and down in a rectangular orifice in this block's lower face there must be a recess accurately fitting the car



SKETCH OF TESTING APPARATUS FOR CAR WHEELS

A frame, B centering rod, C vertical sliding block, D buffer block, E vertical piston, F horizontal piston, G and H cylinders, I wheel, K railroad rail.

wheel's flange and tread accurately tangent throughout an arc the chord of which must extend back for ¼ in. onto the tread for additional resistance.

The opposite lower side must be a rail or a rail head on which the wheel rests. This rail must be reinforced at the head for greater resistance. In this manner the wheel being free horizontally, the pressure is exerted on the flange in a similar manner by pressing on the rail head as obtains with the wheel in service. A wheel to make a flange test must have the central orifice centrally reamed out at right angles to the plane of the wheel. The hub must be smoothed up by planing or turning in a lathe accurately at right angles to the central orifice.

An iron or better, a steel rod, must be put into this central orifice which will just allow of its easy introduction and withdrawal. This rod must be tapering at the end for about an inch and the taper must project so that a buffer block can be placed over the taper between the hub of the wheel and the piston of a hydraulic ram. This accurately centers the buffer block over the hub of the to be tested wheel.

This buffer block must also be turned in a lathe so as to be round and true and be just large enough to cover the hub. It must have a recess made accurately to fit over the taper of the rod. This buffer block must be of sufficient thickness to stand up under the heavy pressures used. The block's faces must be in parallel planes.

The center of the interspaces between the brackets on the wheel must be correctly marked so as to enable placing and fastening directly over a mark on the frame and rail. And just so for over the brackets. The wheel must be fastened centrally over the piston of the hydraulic ram.

The vertical ram piston pressing on the vertical pressure block which represents the car's weight can be accurately adjusted to the several weight wheels by forcing the ram piston a little beyond the required pressure and then by means of a fine thread opening drip cock drawing off enough of the liquid as will make the needle show the desired pressure.

In this way only can wheels be tested so that the tests are of any value. And incidentally this avoids the guesswork method of centering the buffer block and so prevent slipping one over on a too confiding unsuspecting inspector by changing the leverage to get a resulting low or high test at pleasure.

There are a number of details connected with this work. The centering rod must be removed as soon as the wheel is firmly held in place by the buffer block so that the wheel hangs free while the pressure is applied.

Then a washer of soft sheet iron or of annealed sheet aluminium can be placed between the piston faces and the blocks so as to compensate for any being out of line. The pressure on the vertical piston will be up to 2000 lb. per in. for a 6-in. piston and up to 3000 lb. on a 14-in. horizontal piston, when flange testing

These pistons are best connected to one force pump by a proper system of double extra strong pipes with valves so inserted that the pressure is first put on the vertical pressure block and adjusted to the weight of wheel undergoing test. The pressure at 2000 lb. can be run up to 28 tons if desired. The pressure is then turned onto the horizontal breaking piston.

The pump is calculated for a working pressure of 3000 lb. which for the 14-in. piston gives an effective pressure of 230 tons for a direct acting breaking strain. This is more than three times the strain on a wheel flange in service and more than double the strain called for to pass a wheel by inspection.

A chain hoist on a traveler can be rigged up to handle the wheel for placing in position in the testing machine. And a pinch bar comes in handy for adjusting to guide marks.

Chicago, Ill.

Pennsylvania far outranks all other states in the value of its mineral output. In 1911 this state contributed, exclusive of pig iron, 24.7 per cent of the total mineral output of the United States. The reason for Pennsylvania's undisputed leadership lies primarily, according to the United States Geological Survey, in its great production of coal. It is almost exclusively the source of anthracite, and produces over one-third of the total bituminous output. Pennsylvania ranks second, next to New York, in the value of its manufactures, and stands first as a producer of cement, coal, coke, pig iron, lime, mineral paints, sand and gravel.

Tungsten is used chiefly in making steels that will hold their temper when heated, but it is more generally known as supplying the filament of incandescent lamps. Diamonds are used for drawing tungsten wire for the latter purpose, and wire of 0.0006 in. in diameter is now drawn in quantity. New uses are being found for tungsten in making electric contacts and targets for Roentgen rays.

Transvaal Gold Production.—The number of companies reporting to the Transvaal Chamber of Mines in October, 1912, was 62. The total quantity of ore milled during that period was 2,252,949 tons. There were 9,975 stamps in operation, with an average duty of 8.56 tons per 24 hours. Tube mills in commission numbered 281. The yield for the month was 768,681 fine ounces gold, being about 60,000 ounces more than during the same period of 1911. The yield per ton milled was 6.64 dwt.

Organization

An Outline of Essentials from Engineering Practice

By T. C. Roberts

ORGANIZATION is one of the problems that all executives feel that they are thoroughly familiar with. They feel that their organization is laid out on exact scientific lines. They feel that if they are not getting the results they would like to get that it is not due to any fault of their method of organization, but due to some individual weak link in the chain in the form of a personal factor, and in a great many cases they are right.

There are numerous books written on the subject of organization, and it has been widely discussed, but 99 per cent of the friction or dissatisfaction in your organization is due to your lack of proper organizing ability. You who read this will probably say that it does not apply to your organization, because you have no friction or dissatisfaction among your men. But, let me tell you that you have. It may be, and probably will be, with your best men a carefully guarded secret, and one that they would be very reticent about divulging or discussing, even if approached upon the subject. It is there just the same. Sometimes it is due to some one man in the organization, who may have reason to feel that he is abused, discriminated against, not allowed to advance according to his ability, etc., and sometimes he is right.

It is a fact probably based on the old adage that "familiarity breeds contempt," that a great many—I am even going to say that most executives—fail to appreciate the ability of their own men. Each and every one of us can verify the truth of this statement by reviewing our own experiences, and no doubt remembering some instance where we were pushed aside to make room for some one who had no greater ability than we had; and we could see what those higher up probably did not see; and that was, that the fellow who supplanted us received a considerable part of his experience after he got on the job. He probably, though, was a man of considerable ability and would soon be able to introduce new and better methods into the organization, and if we will be absolutely fair in our reminiscences we will probably be able to recall some fellow whose place we took, who, if given the same support that we were accorded, would have been a better man than we were, and who probably proved it in some other organization.

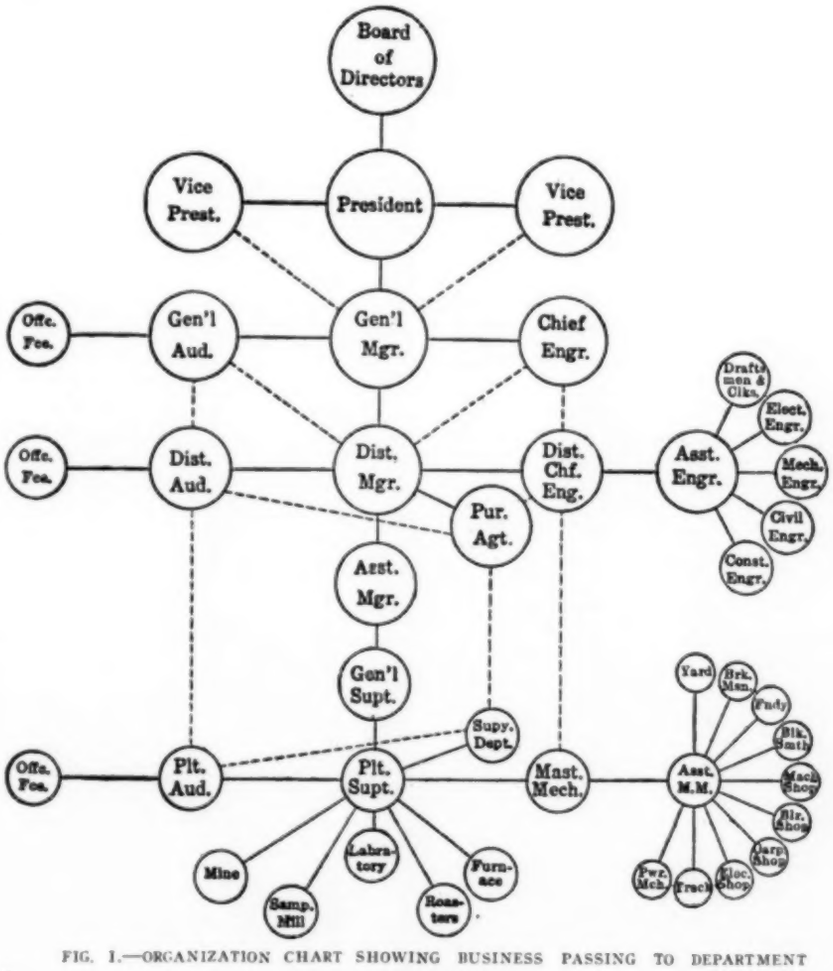


FIG. 1.—ORGANIZATION CHART SHOWING BUSINESS PASSING TO DEPARTMENT HEADS THROUGH ASSISTANTS

The mistake that is made the greatest number of times is one of not outlining each man's duties, and demanding that everybody keep on their own side of the line. How often do you go to some man in an organization and ask him who has charge of certain work, and receive the answer that "if things were as they should be that he would have charge of that work, but as it is some one else has charge of it." Now, Mr. Manager, there is something for you to think about. That man is in one of several classes, and that answer was prompted from one of several causes. It was a case that was probably never brought to your attention. It might have been the only time that that particular man ever gave utterance to what he really felt, yet how could you know that the feeling existed? I will tell you how. If you are a competent organizer you will be able to figuratively put yourself in the place of every man in your organization, and will analyze what your feelings would be if the system were applied to you.

A great many times your system is too flexible, and it would do you good to make an organization chart showing how many paths a report could take in getting to you. In other words, how many chances the man below has to get around the man above. And, how many times you offended some foreman by going around him to some man below, thereby licensing things to get out of their right channel, and making it possible for a weak character to tell somebody, in strict confidence, that when the "Old Man" wants to really know anything about the work-

ing of things he ignores those above and comes directly to him. Which remark, made in the strictest confidence, gets back to the man in the middle, who immediately and rightly gets peevish with you and the man below.

New blood in an organization brings new ideas, and a great many times new improvements, because the new man in trying to familiarize himself with the conditions sees a chance for improvement. While the new men may bring in new ideas, the old men in charge of various departments, by taking an occasional trip through other plants, would be just as quick to see and bring back ideas that would more than pay for the expense of the trip.

Different managers use different methods in keeping in touch with what is going on. Some do not believe in giving too much authority or putting too much confidence in any one man, and adopt the theory that if they want to know what is going on in one foreman's department that they should ask the foreman of some other department to make them a report on the other fellow's work, and yet this class of managers think they know all about maintaining harmony and satisfaction in an organization.

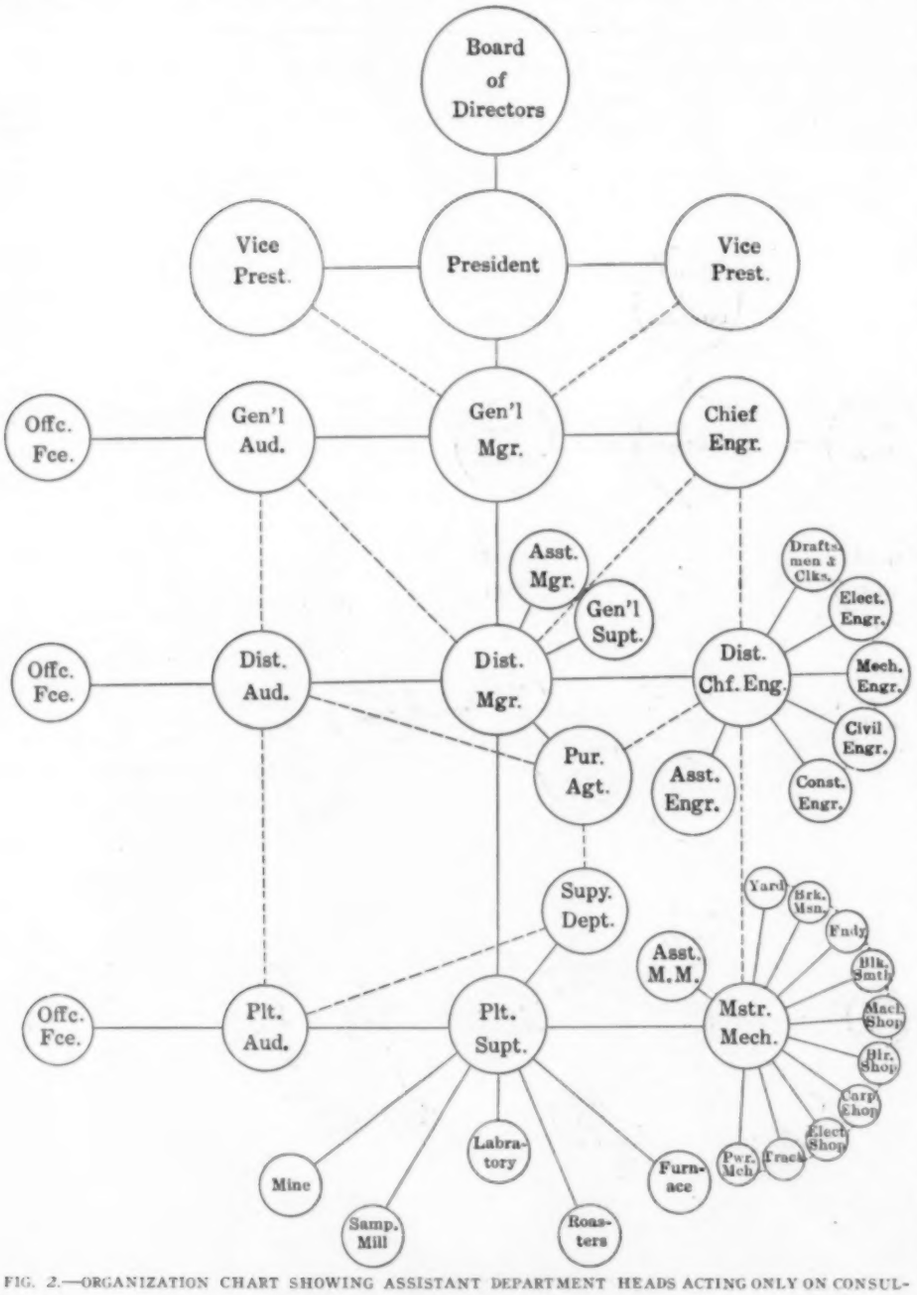


FIG. 2.—ORGANIZATION CHART SHOWING ASSISTANT DEPARTMENT HEADS ACTING ONLY ON CONSULTATION WITH DEPARTMENT HEADS

Another method, and I believe the most successful one, is to carefully define the duties of every foreman or superintendent, and where there is a chance of the duties of one department to overlap another the line should be very carefully drawn. This, you may say, is impossible, but it is not. By giving careful attention to the matter, you will find a point where the line can be drawn with satisfaction to all parties concerned. Do not assume that any two men will work in harmony in a case of this kind, because they will not. If a man is ambitious to make a record that will some day land him in a higher position, it is human nature, when opportunity presents, to show the management how much he knows about the other fellow's job.

In other words, we all try to show that we are fitted to handle anything that is offered, and it is this very thing that will forever keep "Damon and Pythias" brotherly love out of the business organization. And, you can not blame any one of a dozen foremen in a large organization, and who are on an equal basis as far as salary and importance of position are concerned, for endeavoring to show the management that he is better fitted to fill a superior position than any one of the other foremen in his class. And, if in calling attention to his ability he gets on the other fellow's territory you can not expect the other fellow, who is equally ambitious, to not retaliate in kind, and there is a condition to watch.

One of the hardest conditions to meet is the impatience of men to wait a long time for promotion, and it occasionally creates trouble, because men striving for recognition and success in the line that they are engaged in are not prone to sit down contentedly and wait for a vacancy to occur, but they are liable to call attention to the other fellow's failings in the same breath in which they sing their own praise.

A properly arranged organization chart, showing the line of succession, will do as much toward keeping the business in its proper channel as any other one thing, and these charts can be posted throughout the works so that no man would have an excuse of ignorance for going out of the proper channel, except in case of emergency. Also a chart should be drawn in lines of two different kinds, one showing the course to take normally, and the other showing the course to take in case the proper channel is closed.

Some managers prefer to have all reports from the works come up in line of succession through their assistants, as shown in Fig. 1, and some prefer to have the reports come direct to them, and they then assign to their immediate assistants the work that each one is to check (Fig. 2). It takes only a few minutes' time to lay out such charts and they are very valuable, as has been proven by experience. Continuous lines show path to be used under normal conditions, dotted lines show path used in cases of emergency.

In addition to the general chart, each department should have

a detail chart showing the department lineup. Try it and see what results you get. You will probably find several men will offer in explanation of their actions in the past regarding certain things, that they did not know that they were supposed to take such matters up in the manner outlined on the chart. You will probably be surprised to find out how little each man knows of what your intentions really are in your system of organization.

I recently read an article in a technical magazine on the subject of organization. Also, the editor's comments on the same. Both the author and the editor seemed to be offering a solution for a difficulty that had arisen in a certain organization, due to the difference in training between an operating and a construction engineer. They seemed to feel that there was such a great difference that they would not be able to agree on any subject pertaining to their work, and therefore should be kept entirely separate, and each one report separately to the president of the company.

This division often confronts the manager of a large organization. But, to the man who is in close touch with the situation, the solution is apparent. The men in the operating department have probably for several years been operating their plant more or less successfully. If any difficulty has developed they have solved the matter in a manner satisfactory to themselves. They know the weak spots in their equipment, and what should be done to strengthen them. Working along these lines the time comes to install new equipment. The engineering department is consulted, through the chief engineer. Plans should be worked up, in consultation with the operating department; the designing engineer, the operating engineer, and the construction engineer working together under the supervision of the company's chief engineer.

When the plans are out, material purchased and delivered, the actual work of installing the plant should be under the direction of the construction engineer, who has outlined his method of procedure by familiarizing himself, in consultation with the operating engineer, with the conditions in the operating department effected by the construction work. But, both of these men should be under the supervision of, and report to, the chief engineer, the chief engineer in turn making his report to the manager or president.

It is absolute folly to argue that operating engineering and construction engineering should be divided into two departments, each one working absolutely independent of the other, and each one reporting to the president, as suggested in the article mentioned above. In a great many cases the president or manager, as the case may be, is not familiar with the dividing line between the operating and construction engineering. Therefore, both these departments, along with all other engineering work of any nature, should be under the supervision of, or referred to the chief engineer.

If more managers would realize this fact there would be less costly experimental work and time lost by the head of some department trying to work out some pet scheme of his own, without the aid of the engineering department. I have known of various organizations where the foremen or superintendents of the various departments, for fear that they would not get credit for ideas originating with themselves, have worked out their own engineering problems, which is entirely wrong if the organization is maintaining an engineering department.

The engineering department, through the chief engineer, should be directly responsible to the manager of the organization, and all matters going into or out of the engineering department should pass through the manager, or his immediate assistants. I am familiar with one mining and milling organization whose policy it was to keep each division of engineering separate. That is, they had a chief mechanical engineer, a chief civil engineer, a chief electrical engineer, and a chief hydraulic engineer. Each branch had its own assistant engineers, draughtsmen, clerks, etc. Each chief engineer was reporting directly to the general manager. They were in a constant turmoil. If there was a piece of work to design affecting more or less all of them, each department would design a proposition as they thought it should be. Each one holding out for his particular design, with a consequent delay, and a hybrid creation when the job was finished.

This condition prevailed in this organization, which was no small affair, until some one suggested the appointment of a general chief engineer, and while it was true that the chief engineer of each department felt that he should be appointed as the general chief engineer, yet when the company appointed a man from outside the organization, they all fell into line, the engineering departments were consolidatd with each of the original chief engineers as the head of a department of their particular line of work.

Two other organizations that I am familiar with, one the American Smelting and Refining Company, and the other H. M. Byllesby & Company, one a mining, milling and smelting company, the other an engineering, holding and operating company are laid on very similar, and along the lines that outline each man's duties and I would like to see, in the interest of scientific organizations, a complete organization chart of each of these companies published, but I am satisfied that any one sufficiently interested could obtain a general outline of the plan of organization by communicating with these companies.

It is true, however, that in lining up your organization you will probably find some one in the organization whose ideas differ from your own, but that person should, as Hubbard says, "Get out or get in line," and unless every person in the organization will try to make the system as outlined a success, whether it is in accordance with their views on the subject or not, they are an undesirable factor in the organization, and should be eliminated.

United Verde Copper Company,
Jerome, Arizona.

Note on the Calibration of Optical Pyrometers

By Paul D. Foote

In the primary calibration of all forms of optical pyrometers it is necessary to sight upon a substance in which the temperature distribution is such as to obtain "black body" conditions. The Lummer and Kurlbaum electrically heated black body is in general use for this purpose. As modified by Waidner & Burgess[1] by the introduction of a supplementary heating coil at each end, very uniform temperatures may be maintained over a short length of the furnace. However, it is only after the most careful adjustment of diaphragms and the auxiliary heating circuit that platinum and carbon placed inside the "black body" become indistinguishable.

If the walls are very much hotter than the back diaphragm upon which the couples are mounted and the pyrometer sighted, light will be reflected from the diaphragm, and an apparent temperature higher than the true temperature is observed. On the other hand, a large temperature gradient through the furnace may lower the emission so that the thermocouples indicate a temperature higher than that shown by an optical pyrometer.

A method has been suggested[2] which eliminates the rather complicated and expensive apparatus necessary for the Lummer-Kurlbaum "black body." The optical pyrometer is sighted on the bottom of a porcelain tube, preferably blackened inside, the tube being thrust in a crucible of molten metal at the freezing point.

Dr. C. W. Kanolt[3] has applied this method to the calibration of the Morse pyrometer (and Holborn-Kurlbaum type of that pyrometer) by sighting upon a small carbon tube projecting into a pot containing about 100 grams of molten metal. This was placed in an Arsem vacuum furnace and the freeze or melt observed through the glass window of the furnace.

By slightly modifying the above methods, a simple and inexpensive "black body," which may be constructed without dif-

[1]Bureau of Standards Reprint No. 55, p. 165.
[2]Burgess and LeChatelier. The Measurement of High Temperatures, 3rd ed., Wiley, 1912, p. 332.
[3]Bureau of Standards Technologic Papers, No. 10, p. 8.

ficulty in the shops of any industrial plant, has proved highly satisfactory for work at the Bureau of Standards.

A large graphite crucible E, Figure 1, was made, capable of holding 1000 to 1500 grams of metal, D. The graphite cover containing the cylindrical "black body" B, was turned on a lathe and a conical hole drilled through, making an opening of about 0.5 cm. at C. In this manner the radiation coming from the black body passed into the pyrometer and none was intercepted by the graphite walls, the dotted lines, H, representing the cone of rays required by the optical system of the Holborn-Kurlbaum pyrometer. Over the metal was placed a layer of powdered graphite, G, in order to prevent oxidation. A stirring rod, A, could be used to insure a uniform temperature through the pot, although the high conductivity of the metal probably makes this unnecessary.

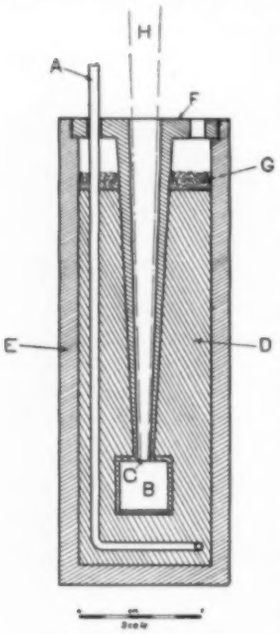


FIG. 1—GRAPHITE "BLACK BODY"

The pot was heated in an electric furnace constructed by winding nichrome or platinum ribbon upon a porcelain cylinder 8 x 35 cm. However, if due care is taken to pack the crucible in a bed of powdered graphite, and some protection is afforded against the stream of oxidizing air, a simple gas furnace will serve very satisfactorily. Pots which have been in use twenty or thirty hours as yet show little sign of crumbling.

As a practical test of blackness, it is interesting to note that the opening, C, was indistinguishable and the only means of superposing the lamp filament and the image of the opening was by allowing a few drops of water to fall into B when for a moment C would appear as a dark spot in the field. Melts or freezes running from fifteen minutes to an hour are easily obtained with antimony, silver, copper and other metals. A typical freeze for antimony is shown in Fig. 2. The flat part of the curve at once shows the current through the pyrometer lamp corresponding to the freezing temperature of antimony (630 deg C.). By the use of the melts of three metals, the parabolic empirical relation $i = a + bt + ct^2$ may be established.

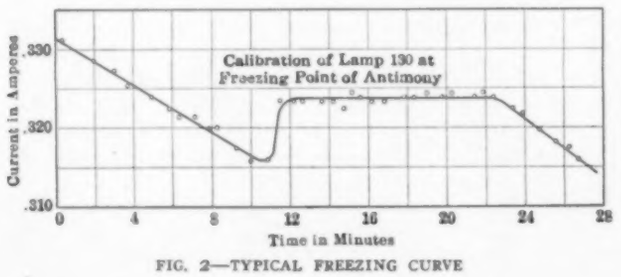


FIG. 2—TYPICAL FREEZING CURVE

If an observation at 1200 deg. C. is desired, inasmuch as there is no metal known to have a melt at this temperature, copper may be superheated and its temperature measured by means of thermocouples immersed in the liquid. However, when observations are made upon copper (1083 deg. C.), copper-silver eutectic (779 deg. C.), and antimony (630 deg. C.), the curve extrapolated as far as 1200 deg. C. reads identically with values obtained on the Lummer-Kurlbaum furnace at that temperature, and even as high as 1400 deg. C, the divergence between the extrapolated curve and the values actually observed is less than 10 deg., an amount of minor importance in industrial work. For higher temperatures an absorption glass should be used both on account of the inadvisability of extrapolation over so great a range and for the safety of the pyrometer lamp, the filament of which begins to deteriorate, slightly, in this region.

Meyer[1] has suggested the use of an equation of the form $i = aT^n$ for the calibration of pyrometer lamps, where a and n are observed constants and T is the absolute temperature. This assumes[2] the filament to be of such a length that the thermal conduction along it is negligible. Both equations have been tried for several pyrometer lamps of the Bureau of Standards, and the parabolic form seems to fit the observations much more closely than the exponential equation. The latter form, however, possesses a distinct advantage in that only two points are required for calibration, but when used, it is necessary to know that the amount of heat dissipated by conduction along the leads is small in comparison with the total energy required by the lamp.

While the method of calibrating pyrometers by means of melts of certain metals as described above, is particularly intended for the Holborn-Kurlbaum pyrometer, it may be used just as satisfactorily with any form of optical pyrometer, care being taken that the cone of rays coming from the opening of the "black body" is not intercepted by the wall of the conical tube, and that the aperture is large enough to completely fill the optical system of the instrument.

Bureau of Standards.
Washington, D. C.

Effect of Heat on Amalgamating and Concentrating in Cyanide Solution

The use of warm solutions in cyaniding gold and silver ores, more particularly the latter, is no longer an innovation. Data on the practice are not as numerous as could be desired, but several instances are recorded in which warm solutions favorably affected extraction and settling. In some cases, perhaps, the results have shown little if any improvement over the use of solutions at normal temperature. This has been true of some silver cyanide mills of Mexico. Opposed to this, however, is the experience in silver cyaniding at Tonopah[3], where solutions at 90 deg. F. materially increased extraction. In South Africa[4] solutions are heated to temperatures ranging from 90 deg. to 120 deg. F., with beneficial effect on settling and a consequent increase of 20 per cent in tonnage treated. Other instances[5] of the use of warm solutions can be found in the practice at the Hudson and Ophir mills, Colorado. Perhaps the most that can be said of the practice is that, in some instances, warm solutions are beneficial, whereas in others only negative results have been obtained.

Through the courtesy of the Liberty Bell Gold Mining Company, Telluride, Colo., we are able to present some interesting data regarding the effect of cold and warm solutions, particularly referring to amalgamation in cyanide solution. Metallurgical practice at the Liberty Bell mill[6] includes stamping in cyanide solution, with subsequent amalgamation after both stamps and tube mills. Prior to April, 1912, cyanide solution was used at ordinary temperature, say 60 deg. F. Beginning with April, 1912, there was a marked increment in solution temperature, and a notable increase in percentage extraction of silver. The natural assumption was that the increased saving was due to better cyanide extraction. But upon tabulating the percentage recoveries from the different mill departments, some unexpected figures were obtained, which did not wholly confirm the first assumption. The following table gives typical percentages of recovery in the different departments over a period of one year, with an opportunity to compare the results obtained during the first half of that time, when cold solutions were used, with those of the last half when the solutions were warm.

[1]Meyer, Diss. Greifswald, 1911.
[2]Pirani and Meyer. Zeit. für wiss. phot., October, 1911, p. 135.
[3]*Min. & Sci. Press*, Jan. 27, 1912, p. 176.
[4]Rand Metallurgical Practice, Vol. I, p. 223.
[5]This journal, Jan., 1912, p. 27; Jan. 1913, p. 25.
[6]Notes on the Liberty Bell Mine, C. A. Chase, Bull. 60, A.I.M.E.

A marked gain is seen in total silver recovery, amounting to 10.57 per cent. Forty per cent of this gain, however, is by

	Percentage Recovery.							
	Gold.				Silver.			
Period.	Amal.	Cyan.	Conc.	Total.	Amal.	Cyan.	Conc.	Total.
First half.....	48.98	35.71	7.52	92.21	7.12	37.67	17.24	62.03
Second half.....	50.20	34.40	8.40	93.00	11.30	39.70	21.60	72.60
Gain second half.	1.22	....	0.88	0.79	4.18	2.03	4.36	10.57
Loss second half.	....	1.31	....	....	....	....	....	....

amalgamation, and another 40 per cent by concentration, with only 20 per cent by cyanide.

Some laboratory tests were conducted to check the results obtained in the mill and to explain the distribution of the gain in silver recovery in the different departments. The following amalgamation tests with hot and cold pulp (barren solution) are suggestive.

Amalgamation Tests.

Test No.	Mg. Silver in Ore.	Mg. Silver Recovered in Amalgam. Hot 85°.	Mg. Silver Recovered in Amalgam. Cold 60°.	Per Cent. Silver Extracted by Amalgamation. Hot 85°.	Per Cent. Silver Extracted by Amalgamation. Cold 60°.
1	61.8	2.18	2.90	3.5	4.7
2	"	5.41	1.65	8.7	2.7
3	"	5.50	2.95	8.9	4.8
4	"	2.68	1.58	4.3	2.5
5	"	5.95	3.46	9.6	5.6
6	"	4.22	3.94	6.8	6.4
7	"	6.86	2.90	11.2	4.7
8	"	9.62	3.16	15.5	5.1
9	"	4.80	2.60	7.8	4.2
10	"	7.96	4.47	12.8	7.2
11	"	8.20	4.50	13.2	7.3
12	"	8.16	3.70	13.2	6.0
13	"	5.42	4.35	8.7	7.0
14	"	5.59	5.62	9.0	9.0
Mean	61.8	5.86	3.42	9.45	5.52

The figures show nearly 90 per cent increase in amalgamation at a temperature of 85 deg. F. as compared with 60 deg. F. Similarly the following agitation tests in cyanide solution show an increased extraction of both gold and silver at the higher temperature, although the gain is not so marked in the case of gold as with silver.

Agitation Tests.

Ore assay: Au. 0.20; Ag. 2.06.

Test.	Temperature 85°. Tail Assay.		% Extraction.		Temperature 60°. Tail Assay.		% Extraction.	
No.	Au.	Ag.	Au.	Ag.	Au.	Ag.	Au.	Ag.
1*	0.018	0.58	91.0	68.5	0.020	0.53	90.0	74.2
2	0.012	0.65	94.0	71.5	0.022	1.32	89.0	35.7
3	0.012	0.75	94.0	70.3	0.022	0.92	89.0	55.2
4	0.012	0.65	94.9	72.7	0.022	0.72	89.0	65.0

*Temperature on this cold test may have exceeded 60°.

It will be noted from the above tabulated amalgamation tests that the increase in silver extraction with warm pulp is fairly consistent. The gold increase was more erratic. This led to the suspicion that silver was being precipitated on and amalgamated with the mercury after first being taken into solution by cyanide. To confirm this view the following amalgamation tests were then made, using only mercury and zinc-box head-solution, with no ore. The same quantities of mercury solution were used as in the preceding tests with ore and barren solution, and the test was conducted for the same length of time, with the following results:

Test No.	Mg. Silver Precipitated on and Amalgamated with Mercury. Hot 85°	Cold 60°
1	3.54	1.10
2	4.20	0.80
3	3.46	0.86

The increase in silver precipitated on and amalgamated with the mercury in the case of the warm solution was 8.1 per cent of the dissolved silver in the solution.

The average silver recovery in mill amalgamation for the period October, 1911, to March, 1912, inclusive, when cold solutions were in use, was 7.09 per cent. The same average for the following six months with warm solutions was 11.30 per cent, showing a gain of 4.21 per cent. The average silver content of the mill ore during the latter period was 2.45 oz. per ton. The apparent increased silver recovery by amalgamation during this period was, therefore, 0.103 oz. per ton of ore treated.

The average quantity of dissolved silver in battery solution during the latter period was 0.297 oz. per ton solution. Assuming five tons solution used in the batteries per ton of ore treated, and 8.1 per cent more of its dissolved silver to have been precipitated and amalgamated on the plates than during the preceding six months, the increased quantity amalgamated amounts to 0.1202 oz. per ton of ore, or an apparent increased silver extraction of 4.91 per cent.

The indications are, therefore, that the apparent increase in silver extraction by amalgamation during the last six months is in reality an increased recovery by cyanide, probably due, as shown by the accompanying agitation tests, to the increase in solution temperature. The total increase in silver recovery should, then, more properly be credited to cyaniding and concentration, including in the former item that increase which is shown in amalgamation.

The foregoing results seem to indicate that, at least in this instance, heating is beneficial, and that the processes of amalgamation cyaniding and concentration are materially improved when performed in warm solutions. The reason for the gain in silver recovery by concentration probably is explained by the effect of heat on the settling process.

The Present Status of the Induction Furnace

The New Two-Phase Combination Furnace and Details of Lining Construction

In the London *Electrician* of December 13, Mr. **John Härdén** gives an interesting review of the present status of the induction furnace and of some recent advances in design and construction. From this article we extract the following information:

"Development in the past has been somewhat handicapped by the fact that certain of the distinctive types of induction furnaces have been controlled by different interests, and a step in the right direction has been achieved by a recent combination of these various interests, by which the exchange of information relating to results obtained in the European countries and in America is made easier, while, in addition, it becomes possible to make combined use of the good points of the various patented types in designing future furnaces.

"In Great Britain the induction furnace interests are in the hands of the Gröndal Kjellin Co. (Ltd.), of London, who now control the patents covering the Kjellin, Röchling-Rodenhauser and Frick types of furnace. The distinction between these three types is sufficiently well shown for the present purpose by Figs. 1 to 4.

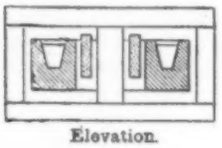
"Neglecting those furnaces which have been erected from time to time for experimental purposes, there are now working, or under construction, nine Kjellin furnaces, with a total capacity of about 17 tons; seventeen Röchling-Rodenhauser furnaces, with a total capacity of about 57 tons; and one Frick furnace, with a total capacity of 12 tons. At a low estimate these furnaces would be capable of producing some 100,000 tons of high-grade steels per annum.

"It was inevitable that some trouble should have been experienced in the development of these furnaces. . . . The metallurgist who is to use it is confronted with a device which provides him with a receptacle in which to handle his metal, of an unaccustomed shape; he has available a means for heating his metal more rapidly and to a higher temperature than is possible in the usual types of metallurgical furnace; and, finally, he finds that his molten charge is automatically and very effectively stirred, due to electromagnetic effects. Being of a conservative nature, he quails before such a wealth of improvements, and is inclined to upraid the 'electrician designer' for wasting his time with such a 'box of tricks.' His interest has been aroused, however, and, with the aid of his valuable suggestions, improvements are rapidly being made in those points relating to both construction and procedure which may truly be said to come within his province.

"These remarks are made to emphasize the fact that success can only be obtained by means of the closest co-operation between metallurgist and electrician. An abundance of results have been recorded which prove beyond question that

the induction furnace is a device by means of which all the metallurgical operations requiring the melting and refining of raw materials for the production of finished steels can be performed with at least equal, if not better, results than can be obtained by any of the methods generally adopted."

Mr. Härdén then discusses the outlook in various countries, with special reference to Sweden and Norway, Germany and particularly England. Concerning the United States the author says: "So far as future development in the use of electric furnaces is concerned, the prospects are far brighter in the United States and Canada, more particularly in the States, than in any part of Europe. Here exists an enormous and ever-increasing demand for home consumption, which under the present tariff laws must be met largely by home production. This production on a large scale and at consequently lower rates, coupled with the low cost of Atlantic freights, will probably make it possible, as in other industries, to compete with the makers in Europe, in spite of the long and costly rail freights between the center of manufacture and the seaport.



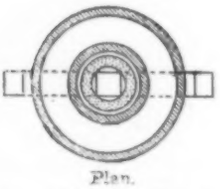
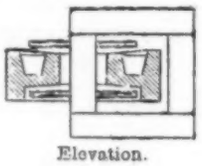


Fig. 1.—Kjellin Furnace.



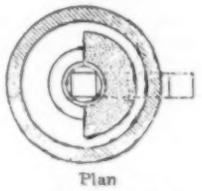
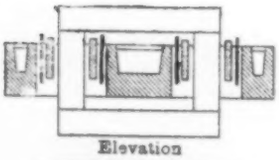


Fig. 2.—Frick Furnace.



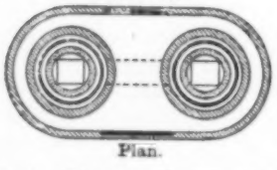
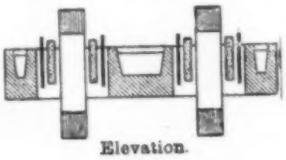


Fig. 3.—Röchling-Rodenhauser Furnace. Single-Phase.



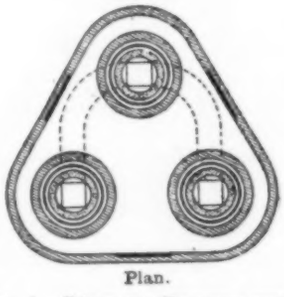


Fig. 4.—Röchling-Rodenhauser Furnace. Three-Phase.

Figs. 1 to 4—Principal types of simple induction and combination furnaces

Production on an enormous scale will be as much the maxim of the American manufacturer of high-grade steel as it is with the manufacturer of other commodities. Here, then is an almost ideal field for the induction furnace, since the demand for high-grade steels must be great and the facilities for producing cheap electric power, either from water-power, gas or oil are at least as favorable as in any other parts of the world. . . . Although the number of electric-steel furnaces at present working in America is far behind the number in Europe, it requires no abnormal prophetic powers to foresee that in a very few years America will create a record in this as in so many other industries."

As to the outlook in Great Britain the author says:

"In these days of easy and rapid communication, it is idle to suppose that any advantages which the British steel maker may have held over his foreign rival, due to his having exclusive knowledge of those intricate processes for the production of high-grade steels, will long remain with him, and, so far as skill in manufacture is concerned, he must inevitably meet his rival on even terms. In other words, the magic of a Sheffield brand will have departed unless it is backed by a price comparable with that of a corresponding foreign brand. So far as export trade is concerned, the British manufacturer has this advantage over his foreign rival, particularly the American: that a large percentage of his raw material is in close proximity to the manufacturing center, while the manufacturing center is near the seaport. This advantage, backed by a reduction in cost of manufacture, such as may be obtained by the employment of induction furnaces, should ensure that the British steel maker will retain the large share of the world's markets for high-grade steels which he at present enjoys.

Two-Phase Combination Furnace

"The most interesting advancement so far unrecorded is the design of a two-phase induction furnace on the lines of the Röchling-Rodenhauser furnace, by means of which it is hoped to effect considerable economy by reducing radiation losses and by improving the electromagnetic conditions.

"The distinctive features of this new type of furnace will be seen from the diagram in Fig. 5.

"*A* and *B* represent the cores of two identical single-phase transformers, each designed to carry about half the load. *C* and *D* are the two primary coils, separated by annular spaces *E* and *F* from the lining shell *G*. The front and back of the furnace hearth, which is indicated by *I*, are connected by the narrow annular ducts *J* and *K*, which will contain the metal forming the two secondaries of the transformers. Provision is made to prevent the slag from entering and obstructing these ducts. The shaded exterior part represents the lining surrounding the hearth *I* and ducts *J* and *K*.

"It will readily be seen by a comparison with the diagrams 3 and 4 that this form of furnace has several advantages over the single and three-phase arrangements, both of which types have been built. The complication of the three-phase furnace hearth and roof were soon found in practice to be so great that the type has now been abandoned, in spite of the fact that the electromagnetic conditions, as compared with those in the single-phase furnace, were much improved. In the case of the single-phase furnace the shape of the hearth and roof is extremely simple, and many furnaces of this type are giving excellent results in practice. The electromagnetic conditions are, however, less satisfactory, and an improvement in this respect is desirable.

"In the arrangement of the two-phase furnace shown above, it is hoped to combine the good points of both the three-phase and single-phase types. It will be seen that the shape of the hearth is identical with that of the single-phase furnace, while, owing to the fact that the cores surround the narrow heating channels, and not, as in the case of the single-phase furnace, the wide hearth containing the greater part of the charge, which must, for mechanical reasons, be separated from the core by a considerable space filled with lining material, the magnetic leakage is considerably reduced and a higher power factor results.

"A further advantage is gained by the fact that the lining of the hearth may be designed with a view to reducing the radiation losses to a minimum, since the space devoted to this part of the lining will not have such an appreciable effect upon the electromagnetic conditions as is the case in the single-phase type. The use of the two-phase type does away with the necessity for introducing an expensive motor-generator set, with single-phase low periodicity generator, between the furnace and any existing two or three-phase supply.

"In the case of the larger size of furnaces, and if the periodicity of the supply is normally high, the power factor may be regulated by the installation of a rotary condenser. For a three-phase supply the regulating transformer, for varying the voltage at the furnace terminals and consequently the temper-

ature, may be designed on the Scott principle. By designing the furnace transformers for normal-periodicity current the iron section of the core becomes much less than is the case with the low periodicities, which are essential to large single-phase furnaces.

"As a matter of interest to the electrician, I give a diagram, Fig. 6, of the switching gear and connections which would be employed for a two-phase furnace supplied with power from two-phase mains. The voltage-regulating transformer would be arranged for hand operation, and is preferably in mechanical or electrical connection with the circuit-breaker, in order satisfactorily to break the large inductive load before switching over from one step to another on the regulating transformer.

"The furnace itself, being in reality merely a short-circuited transformer, will stand the sudden switching on or off of high currents without any ill effects."

In Fig. 6 *A* is a voltmeter; *B*, ammeter; *C*, wattmeter; *D*, synchroniser; *E*, power factor indicator; *F*, voltmeter; *G*, voltmeter; *H*, to synchronous motor; *I*, to induction motor for starting synchronous motor; *K*, furnace transformer coils; *L*, regulating transformer.

The electrical load of an induction furnace is not subject to large fluctuations. "It is, indeed, almost entirely under the control of the operator, the slight automatic change in the electrical conditions being due to the effect of the chemical and thermal changes in the bath, and, since these only take place slowly, no ill effect results from it. This is particularly the case with a furnace used for the treatment of hot metal, since less thermal change takes place in the charge during the time of its treatment."

Construction of Lining

In discussing the heat insulation of electric furnaces, the author refers to Dr. Carl Hering's articles in this journal on the subject. As to the unit "thermal ohm," he says: "This nomenclature, I fear, is somewhat apt to be misleading, and will, no doubt, be improved upon." But "those of us who are interested in the question of electrical furnaces cannot but feel indebted to Dr. Hering for raising this most important question in so able a manner.

"In addition to its heat-insulating value, a lining must, besides being of sufficient mechanical strength to carry the charge, be capable of withstanding the internal strains set up by expansion, while at the same time it must be dense enough to prevent excessive percolation of molten metal through the interstices between the particles of which it is composed. Its chemical effect upon the composition of the charges is, of course, also of great importance.

"In any furnace all these qualities are very desirable, but in

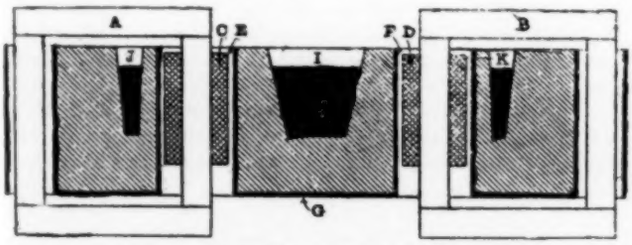


FIG. 5—TWO-PHASE COMBINATION FURNACE

none so much as in the induction furnace, and in none are they more difficult to attain. The high temperature possible, the automatic motion of the molten metal, both most desirable characteristics when under control, and the peculiar shape of bath, make the design and construction of the lining one of prime importance.

"In the first 1½-ton induction furnace built by Dr. Kjellin, at Gysinge, an acid lining consisting of silica brick was used. It was found, however, that too much silica was absorbed by the steel, probably due to the eroding action of the circulating metal, and it was soon abandoned in favor of a basic lining, which was constructed as follows: 10 kg. of finely ground burnt magnesite were mixed with every 500 kg. of sintered magnesite, to which were added 40 kg. of Holland clay, reduced to a paste with water and some boracic acid; when it was ready for ramming in the furnace round a suitable template. For a complete lining up to the level of the molten metal some 2700 kg. of this mixture was used. The lining above the level of the metal was finished with a course of magnesite brick. On this lining 285 tons of steel from cold material, representing about 210 complete charges, could be produced.

"The use of water in bringing the lining mixture to a proper

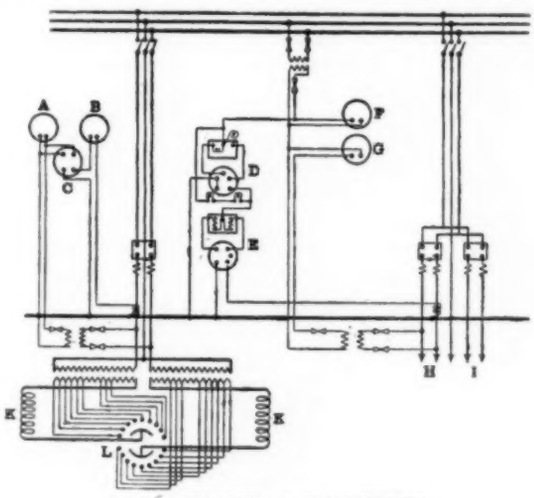


FIG. 6—DIAGRAM OF CONNECTIONS

degree of plasticity, to enable it to be rammed into place, was improved upon later by the use of hot tar, with which it is possible to obtain a more homogeneous and less porous lining, better calculated to withstand the tendency of the molten metal to percolate through the pores.

"The Röchling-Rodenhauser furnaces at the Röchlingsche Eisen & Stahlwerke, at Völklingen, in Germany, and at Vereinigte Hüttenwerke Burbach-Eich Düdelingen Akt.-Ges., at Luxembourg, are all lined in the following manner: The furnace castings are first protected by means of layers of firebrick, which also serves to a large extent as the principal protection agaist radiation losses and rarely require replacement. On the bottom surface of firebrick is first rammed, by means of automatic stamps, to the level of the hearth bottom, a layer of a mixture of carefully roasted dolomite and tar, ground and intimately mixed in suitable mills. Templates of cast iron for shaping the hearth and the heating channels are then placed in position, and more of the lining mixture is rammed round them, after which they are removed and the top of the lining finished off with dolomite bricks.

"The roof of the hearth and the heating-channel covers are formed of silica bricks carried in suitable frames. Before placing the roof in position the lining is dried by placing cast-iron rings in the channels, the temperature of which is raised gradually to a point just below the melting point of the cast-iron rings by increasing the current in the transformer winding. These rings may be well coated with graphite and oil to retard oxidation. As soon as vapors from the burning tar have ceased to be evolved, the roof and channel covers are placed in position, a charge of molten pig is run in and the temperature further increased to the maximum required to complete the final sintering of the lining.

"In a 4-ton furnace the time required to replace a worn-out lining may be analysed as follows:

Tearing out old lining and ramming in new	24 hours
Burning out tar with hot rings	6 "
Completing the sintering of the lining	6 "

"During the burning and sintering processes some 230 units would be consumed.

"Such a lining as described above will stand from 90 to 125 charges of hot metal, or from 360 to 500 tons, according to the class of steel produced, which determines the time required.

Lining Construction at Poldihütte

"I have already indicated some of the difficulties which have had to be faced in the design and construction of linings, and it will be of interest to give some description of a lining which has been evolved by the Poldihütte Co., a well-known Austrian firm, after much experimental work with a 4-ton tilting Kjellin furnace. This firm, who installed their furnace in January, 1908, early realized the importance of the lining question, and set themselves, with conspicuous success, to solve the difficulties involved.

"The problem was complicated by the fact that the furnace, in addition to being fitted with tilting gear, was mounted upon a carriage, and provision was made for rotating it round a vertical axis to facilitate teeming operations. Under these drastic conditions, with the usual type of rammed magnesite lining, it was found impossible to obtain more than forty-nine charges without a renewal of the lining becoming necessary, on account of the appearance of cracks.

"After much experiment, it became evident that no simple form of rammed lining was suitable for the conditions under which the furnace was handled, and tests were then made with a lining compounded of several layers of materials having different compositions, with a view to localizing the cracks which so rapidly appeared. Working on these lines, so much improvement was made that in 1909 the average number of charges obtained from a lining amounted to about 200.

"From this date improvement was rapid, as the following table of results showing the average number of charges obtained during a period of three months indicates:

First quarter of	1910	227	charges.
Second "	1910	259	"
Third "	1910	262	"
Fourth "	1910	288	"
First "	1911	386	"
Second "	1911	392	"
Third "	1911	491	"

"The final lining evolved, which is fully patented, is indicated in Fig. 7, representing a vertical section of the lining.

"The lining is constructed in the following manner: First the bottom of the furnace shell *M* is covered with a single layer of firebrick *A*; upon this a layer of magnesite brick *B* is laid, using as cement a mixture of magnesite powder, lime and water. The outside of the shell *M* is then laid with a single course of firebrick *C*. Round the inside of this firebrick, and round the outside of the cooling jacket *N*, are fitted spacing pieces of wrought iron, which are fitted into place in somewhat the same manner as the staves of a barrel, and form the templates for the asbestos-wool channels *D* and *E*. The spacing pieces have holes punched in the top ends to facilitate removal, and in the case of those round the cooling jacket *N* are held in place by a steel band, and in the case of those round the firebrick lining *C* by means of wood staging.

"Cylinders built up of three or four sheets of cartridge paper and tracing cloth, with the smooth surface outside, are then placed in position at *G*, and strengthened temporarily by means of well-oiled sheet-iron cylinders. This prepares a space into which a mixture of well-roasted dolomite and tar carefully prepared is rammed. The remainder of the magnesite bricks *H* are now laid upon a sloping layer of magnesite sand *I*, using the same cement as before, while gradually, as the number of courses are increased, the sheet-iron cylinders holding the paper-covered rammed dolomite *F* in place, and which for ease of working are built upon parts, are withdrawn.

"In preparing the mixture for the lining *J* of the heating channel *L* much care is taken. It is made up of an equal proportion of three materials: First, high-grade 'Veit' or 'Styrian' magnesite, ranging in size from 5/8 in. to 1 5/8 in.; second, similar material varying in size from 1/8 in. to 5/8 in.; third, fine crushed magnesite bricks from old linings, with which is mixed 1 per cent. of finely ground 'Thomas' slag. Care is taken to remove all impurities, particularly metallic oxides, as far as possible.

"Equal parts of these constituents are intimately mixed with hot tar until a homogeneous substance is produced, which when squeezed in the hand forms into firm balls. Too much tar will cause the mixture to flow when rammed; with too little it will not bind well. Having prepared this mixture, it is rammed in while still hot on top of the magnesite bricks *H* up to the level of the heating-channel bottom. The channel template of well-oiled cast iron is then placed in position and the ramming completed.

"After drawing the spacing pieces forming the channels *D* and *E* and filling the spaces with asbestos wool, which may be used repeatedly for many linings, the channel template is removed and the lining is ready to be dried in the usual way with cast-iron rings electrically heated.

"To the first charge which is worked about 12 lb. of aluminium are added, with sufficient scale or rusty iron to oxidize it. The alumina formed fluxes the rammed magnesite, forming a surface which resists the percolation of the iron.

"The advantages of this lining are that the troubles due to vibration and expansion in all directions have been to a very large extent overcome. As regards its thermal insulating value, unfortunately there are at the present time insufficient figures available to determine the extent to which improvement in this respect over the more simple types of lining has been effected.

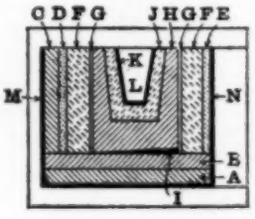


FIG. 7—SECTION OF POLDIHÜTTE LINING

"The conclusions to be drawn from this brief survey of the induction-furnace position may be summarized in very few words. As in all things, there is room for further improvement, and I have tried to indicate upon what lines development is proceeding.

"Up to the present time the scope for the economic use, particularly in England, has not been wide, owing to the fact that they are still somewhat ahead of their time. All evidence, however, points to the fact that the growth of the demand, for which they, as instruments, will provide the supply, is fast reaching those dimensions required to demonstrate that induction furnaces are a necessity to the steel industry.

"Their inherent characteristics are of such value that it is safe to say that they will not be relegated to the limbo of forgotten inventions without leaving an abiding mark upon the history of this age of steel."

Silicon Castings for the Chemical Industries

Pure silicon is a metal of remarkable acid-resisting properties. This has long been a matter of common knowledge, but no use was ever made of it in the technical arts because silicon metal was not available in commercial quantities and also because no method was known of making silicon castings.

As stated in an article on the works of the Carborundum Company in Niagara Falls, published in our issue of May, 1909 (vol. VII, page 192), the Carborundum Company has been the first to produce pure silicon commercially, the process for its manufacture having been developed by its works manager, Mr. F. J. Tone, U. S. Patents 745,122, 833,427, 842,273 and 869,276 (see our vol. II, p. 3; IV, 464; V, 141).

That article contained some notes on the electrical furnace used for the production of silicon, some typical analyses of commercial silicon and a discussion of the various applications of metallic silicon. Among the uses it was mentioned that silicon was produced in the form of small castings, such as rods for electric resistances, but the difficulty of casting perfect forms of metallic silicon was noticed.

Since then great advances have been made in the development of a successful method of casting silicon as the result of long investigation which was attended with the greatest difficulties. All these have now been entirely overcome and it is possible by some recently developed processes to make castings of all ordinary shapes and sizes. Cast silicon chemical ware is thus placed within the reach of all chemical industries.

Properties of Cast Silicon

Density—2.5 to 2.6.

Electrical resistivity—0.15 ohms per centimeter cube at 18 deg. C., decreasing rapidly with rise in temperature.

Thermal conductivity—good (no absolute value determined).

Specific heat—0.176 (17 deg.-100 deg. C.).

Melting point—1430 deg. C.

Boiling point—2800 deg. (calculated).

Hardness—6 on Mohs scale.

Compressibility—0.16 x 10^{-6} (least compressible of any element).

Coefficient expansion—5.39 x 10^{-6} at 100-200 deg. (less than glass or platinum).

Tensile strength—approximately 1000 lbs. per sq. in. (exceeds that of stoneware).

Resistivity of Silicon to Various Chemical Reagents

Sulphuric Acid: Sulphuric acid in any concentration under gentle evaporation has no action on silicon.

When vigorously boiling the loss in grams per square foot in 24 hours is as follows:

Concentration	Grams loss
10 per cent	.0592
20 "	.0829
30 "	.0799
40 "	.0681
50 "	.3197
60 "	.2634
70 "	.1657
80 "	.1391
90 "	.1273
95 "	after initial solubility of .0033 gm. action ceases

Fuming sulphuric acid readily attacks silicon.

Nitric Acid: Nitric acid either dilute or concentrated has little action on silicon. The loss in grams per square foot in 24 hours is as follows:

Concentration	Vigorous Boiling	Gentle Evaporation
5	.0000	.0089
10	.0237	.0207
20	.1391	.0355
30	.2102	.0296
40	.1539	.0888
50	.2072	.1509
60	.2486	.1569
70	ceases after .0352	ceases after .0891

Hydrochloric Acid: This has a slight but continuous solvent action on silicon.

Hydrofluoric Acid: This acid attacks silicon vigorously.

Chlorine and Chlorine Liquors: Silicon metal appears to be highly resistant to these reagents in practice.

Phosphoric Acid: This shows a continuous but slight attack which does not altogether disappear. This results in a slight turbidity in the product treated.

Alkalies: All alkalies readily attack silicon.

Uses of Cast Silicon

Silicon is used in the form of pipes for the conveyance of acid gases at a high temperature from stills to condensers, also in the construction of the condensing batteries themselves, proving much more efficient than stoneware owing to its high thermal conductivity and ability to withstand sudden changes in temperature. Silicon pipes are also used for the transportation of hot liquid sulphuric and nitric acids. It cannot be used for hydrochloric acid unless the discoloration resulting from the slight solubility is immaterial.

As a lining it is used in centrifugal pumps, acid valves and pipes for the elevation of corrosive liquids by compressed air, and for the construction of plows in ore roasters it has proven efficient.

Cast silicon is also being used in the form of shallow pans and pots for the concentration of zinc chloride solutions, supplanting the enameled stoneware vessels which are rapidly destroyed.

Cast silicon ware is produced in practically all shapes required by the chemical industry, such as pipes, evaporating vessels, receivers, tile, alembics crucibles and pump parts. Castings are preferably made at least ½ inch in thickness, excepting pipes less than 2 inches in diameter, which can be made with a ⅜-inch or ¼-inch wall. In the designs of silicon apparatus sharp corners and sharp bends must be avoided so far as possible.

In comparing the cost per pound of silicon castings with the cost of special iron castings used for acid work, attention is called to the low specific gravity of silicon. In silicon castings there is required only one-third the weight of an iron casting of the same form.

Notes on Chemistry and Metallurgy in Great Britain

Institution of Electrical Engineers

The Research Work Committee's report, which the council adopted at a meeting on the 12th of December, advises that the scope of the research work undertaken by the Institution should be such as would avoid over-lapping the work of other societies, and should be confined as far as possible to (a) the organization and correlation of research work in electrical engineering, and (b) the organization and supervision of specific researches in subjects connected with the electrical industry, and the allocation of grants in aid of the same.

The former should include (1) the establishment of a general committee for research to which investigators would be invited to send particulars as to the subject and character of the researches they are undertaking. Members of the institution would also be invited to communicate to this committee any special difficulties they had encountered which called for investigation and to make suggestions for subjects for research; (2) the collection and publication of particulars of plant available for special testing and investigation work in the various laboratories, together with a list of the subjects in which researches have been carried out; (3) the compilation and publication of bibliographies of specific fields of research.

With regard to the heading (b) the committee consider that it is desirable that the institution should originate and direct researches on certain subjects, and suggests that the General Reaserch Committee should have power to appoint sub-committees of experts to deal with researches in selected subjects. Firstly, a series of investigations might be initiated on "the electrical properties of materials," which would deal with such matters as magnet-steel, copper, carbon, paper, rubber, mica, porcelain, oils and varnishes, etc., for which fuller data are required.

The method of co-ordination in research is essentially German in its origin, and has been productive of immense benefit to German science. It may confidently be anticipated that if the recommendations of the Committee of the Institution are loyally carried out very valuable results will be attained.

The Electrolysis of Nitric Acid Solutions of Copper

At the November meeting of the Faraday Society J. H. Stansbie read a paper dealing with this subject. Under ordinary conditions the deposition of the whole of the copper from nitric solutions is practically impossible. In the electrolysis of such solutions nitrous acid is formed; and the fact that this acid has a material action in the solution of copper by ordinary nitric acid suggested an explanation and a partial remedy. Investigation demonstrated that the amount of copper remaining in solution was greatest when the quantity of nitrous acid formed was greatest.

The remedy proposed by the author consists in the addition of sulphuric acid, and the employment of a rotating cathode. He suggested that the effect of adding sulphuric acid is partly that it affords preferential conductance and so reduces the production of nitrous acid; and also that it forms with nitrous acid a nitro-compound having much less solvent action on cop-

per than nitrous acid has. The rotating cathode almost entirely prevents the redissolving of the deposited copper; and thus, with due care, only a slight trace of copper remains undeposited.

Electrically Refined Nickel

Experiments with an electric furnace for refining nickel, at the Technical College, Tronghjem, which have extended over a considerable period, have given very good results; and it is claimed that an electric furnace for the commercial production of metallic nickel has been successfully devised. The Kristiansand Nickel Refining Works will shortly be enlarged to turn out twice their present output; and it is probable that the new furnace will be tried there. The production of nickel in this furnace is stated to be quite satisfactory in metallurgical respects.

The Institute of Metals

Hitherto the annual general meeting of the Institute of Metals has been held in January; but the forthcoming meeting will be held instead on the 11th and 12th of March at the Institution of Mechanical Engineers. Dr. G. D. Bengough will present his second report to the Corrosion Committee which will embody the results of the condenser corrosion tests which have been in progress during the past nine months or so. A committee has been appointed to deal with the nomenclature of alloys; and another committee has been instituted to assist the Dominion's Royal Commission in inquiries as to the supply of non-ferrous metals and their ores.

The nomenclature committee will consist of nine members of the Institute of Metals and one member each of the Institution of Electrical Engineers, the Institution of Mechanical Engineers, the Institution of Naval Architects, the Institution of Engineers and Shipbuilders in Scotland, the Northeast Coast Institution of Engineers and Shipbuilders, and the Society of Chemical Industry.

The Physical Society

The annual exhibition of scientific apparatus, which was held at the Imperial College of Science on the 17th of December, was well attended, and the exhibits fully maintained the standard of former displays. Messrs. Evershed and Vignolles showed a new type of testing set reading up to 5000 megohms; and Messrs. Elliott Brothers' instruments also deserve mention. Messrs. A. Gallenkamp & Company exhibited a laboratory electric furnace in which windings of high resistance wire having a melting point of 1537 deg. C. are substituted for platinum.

Messrs. Gambrell Brothers had on view their new Jordan convection-radiometer and thermo-galvanometer for measuring small and fairly constant thermal changes. The Cambridge Scientific Instrument Company's exhibit included a double range indicator designed for taking steel-hardening temperatures with a thermocouple, and the Whipple temperature indicator. The Foster Instrument Company had their graphic recorder for giving records of temperature with a fixed-focus radiation pyrometer, a thermocouple, or a resistance thermometer, or, alternatively, for recording current or voltage. Mr. R. W. Paul showed several fine single-pivot instruments, an Irwin astatic dynamometer which is not influenced by external fields, and high frequency capacity and inductance measuring apparatus.

Messrs. H. Tinsley & Company exhibited a new type of Drysdale phase-shifting transformer, giving constant voltage at all angles and correct to 12 minutes of phase-angle. The Weston Company had a good assortment of instruments; and the degree of accuracy claimed for some of the direct-current examples is such that they could, for many purposes, be substituted for potentiometers. Messrs. J. J. Griffin and Son gave prominence to gyrostatic apparatus, including the Gray-Burnside motor gyrostat for demonstrating practical applications of the gyroscope and a gyrostatic compound pendulum which has a motor-gyrostat for its bob.

Messrs. Alex. Wright & Company showed improved apparatus for the determination of the amount of fire-damp in air and for the accurate estimation of fire-damp, carbon dioxide and oxygen in the atmosphere in mines. The Marconi company exhibited the radiogoniometer, a new instrument for locating the direction of an emitting source or for regulating the direction of propagation; the British Wireless Telegraph Company showed a vibration proof crystal detector; the Dubilier Electrical Syndicate's main feature was high-frequency apparatus; and Messrs. Nalder Brothers and Thompson had a good exhibit of electrical instruments.

Excellent optical instruments were shown by Messrs. E. Leitz, Messrs. R. & J. Beck, Messrs. J. H. Daelmeyer, Messrs. Carl Zeiss, and the Westminster Engineering Company, but particulars of these and other meritorious exhibits would occupy much more space than is available. Mr. S. G. Brown gave a useful lecture on "Some Methods of Magnifying Feeble Signalling Currents."

The Greenwich Generating Station

Advice gratis is not always worthless, and had the London County Council condescended to give due consideration to the criticisms which appeared in certain technical journals and elsewhere on their decision to put down large low-speed reciprocating engines at the Greenwich tramways generating station, although the turbine had been proved to be unquestionably far superior in all respects for driving generators of large output, some hundreds of thousands of pounds would have been saved to the ratepayers. Three 3500-kw reciprocating sets have been running only about 6½ years, and during the greater part of this period—since the second part of the station, with its equipment of turbine plant, was completed—they have only been called on to supply a very moderate proportion of the output.

Now two of them will soon cease from their stately and ponderous 94 r.p.m. to be replaced by two 8000 kw turbine sets, in the same space; for the Highways Committee has arrived at the conclusion that the turbines will give the 9000 extra kilowatts with a net annual reduction of the coal bill to the extent of some £14,000 or more; and it is proposed to discard the remaining reciprocating engines and replace them with turbo sets of 8000 kw each in the not far distant future.

The aggregate generating capacity of the station will then be 52,000 kw against 34,000 kw at present; while the saving in coal will be something like £25,000 per year at a moderate estimate. Of course, the L. C. C. will want to make the best of a bad bargain and dispose of their magnificent engines with double H.P. and L.P. Corliss cylinders for a good round sum; but the report of the Highways Committee is such a splendid testimonial to their coal-consuming capabilities, as compared with turbines, that the prospect of their fetching more than a tithe of their cost may be much more remote than that of consignment to the scrap heap.

Clyde Shipbuilding

During the eleven months ended on the 30th of November, 258 vessels, having a total of 588,806 tons were launched from Clyde yards. The tonnage for November alone was 71,658 for twenty-nine vessels, and takes second place in the monthly tonnages of 1912. Exact figures for December are not yet obtainable; but a thoroughly reliable estimate puts the Clyde total for the year at 650,000 tons, or 20,000 tons more than in 1911, which was the highest hitherto. This means that more than 50 per cent of the tonnage for the whole of England this year has been put afloat on the Clyde. The warships built on the Clyde this year include the Ajax, 23,000 tons, super-dreadnought, three cruisers, two depot ships, one survey ship, and six destroyers. The liners numbered sixteen, of which four were for the P. & O. Company and five for the British India line.

Engineering Imports and Exports

The returns issued by the Board of Trade for the eleven months ended the 30th of November, show material increase in all descriptions of engineering imports and exports, except imports of ships, as compared with the corresponding period

of last year. Imports of iron and steel, including manufactures, amounted to £11,713,216, and the exports to £44,279,332, the respective increases being £1,578,416 and £4,248,867. The imports of other metals, including manufactures, reached £28,358,042, an increase of £3,294,028; and exports were £11,223,953, an increase of £1,117,744. Electrical goods were imported to the value of £1,320,182, an increase of £23,334; and were exported to the value of £4,049,758, an increase of £1,442,706. Imports of machinery totalled £6,206,125, an increase of £890,569; and exports went up to £30,418,438, an increase of £2,091,938. Imports of new ships are valued at £32,172, a decrease of £30,321; but exports touched £6,237,295, an improvement of £1,349,263. Taking the month of November alone, imports of iron and steel increased £197,664 and exports were £529,125 better; in other metals imports and exports rose £711,533 and £173,450 respectively; imports of machinery were £87,275 higher, and exports increased £34,060; imports of ships increased £4,020, while exports went up £88,393; but electrical goods showed decreases of £8,973 in the imports and £15,775 in the exports.

Market Prices—December

Tin has been on the whole, quiet, considering the usual character of its fluctuations. Opening at £226 it was up to £227¾ on the 2d, and dropped away to 225 on the 4th, and £224 on the 9th. On the 10th it was again rising and reached £227½ on the 18th, and closes at £228-10.

Copper has had a downward tendency, opening at £76½ and dropping to £74-5 by the 6th and £73-5 by the 17th. It then recovered in tone and was £75½ on the 20th and finally closed at 76.

Cleveland has been fairly steady with downward tendency. Opening at 67/4 it had fallen to 66/8 by the 7th, but finished at 67/9.

Scotch Pig has been in sympathy with Cleveland, opening at 73/10 and dropping off after the 11th, it ultimately recovered to 73/9.

Haematite has been steady, opening at 82/-, rising temporarily on the 10th, but dropping again, it closes at 82/3.

Lead. Very steady along £18-10-0 with tendency to rise the latter part of the month; closes, however, at £18-10-0.

	£. s. d.
Aluminium, per ton	88. 0.0
Alum, lump, loose, per ton	5.15.0
Antimony, black sulphide powder, per ton	21. 0.0
Borax, British Refined Crystal, per ton	17. 0.0
Copper, 10 to 25 per cent, per unit	13/6 to 14. 0.0
Copper Sulphate, per ton	25. 5.0
Carbolic Acid, liquid 97/99 per cent, per gal	0. 1.5
Creosote, ordinary good liquid, per gal	3
Caustic Soda, Ash 48 per cent, ordinary per ton	5.10.0
Hydrochloric Acid, per cwt	5.0
India rubber, Para, fine, per lb	4.6¾
Naphtha, solvent, 90 per cent, 160 deg. C., per gal	1.2
Petroleum, Russian Spot	8
Quicksilver, per bottle	7. 8.6
Sal Ammoniac lump, firsts, delivered U.K. per ton	44. 0.0
Sulphate of Ammonia, f.o.b., Liverpool, per ton	13.18.9
Sulphur, recovered, per ton	5. 5.0
Shellac, standard T.N. Orange Spots, per cwt	4. 4.0
Tin Ore, 70 per cent per ton	148/ to 150. 0.0
Zinc, Veille Montagne, per ton	30. 5.0
Platinum, nominal per ounce	9. 5.0

The differences on the month are thus:

Higher.	£. s.d	*Lower.*	£. s.d
Aluminium	3. 0.0	Copper Ore	6
Copper Sulphate	2.6	Quicksilver	4.0
Sulph. of Ammonia	1.3	Tin Ore	2. 0.0
Tin	2.10.0	Copper	10.0
Cleveland	7		
Scotch Pig	1½		
Haematite	3		

London, England.

Synopsis of Recent Chemical and Metallurgical Literature

Gold and Silver

Grinding-Pans vs. Tube Mills at the Homestake.—Experiments in the regrinding of sand at the Homestake mine, South Dakota, have resulted in the adoption of tube mills in preference to grinding pans. The details of the practice with both machines are given by Messrs. A. J. CLARK and W. J. SHARWOOD, in *Bulletin* No. 98, Inst. Min. & Met.

The regrinding machinery consists of seven pans, each 5 ft. in diameter, and a tube mill 5 ft. by 14 ft.

The pans are a modification of the Wheeler type, arranged to maintain a continuous discharge at the periphery, the depth of discharge being adjusted by the use of overflow rings of varying height, which are readily mounted upon the permanent lower portion of the shell. This shell extends 20 in. above the base-plate and determines the minimum depth of discharge.

The pulp fed to the pans is introduced in a distributing hopper, cast about the central shaft and forming part of the muller carriage. This hopper is tapped with pieces of pipe, through which the pulp is led to the bottom of the pan and discharged directly in the path of the mullers.

The total weight of moving parts when the pan has been equipped with new mullers, is nearly 2200 lb., to which total the mullers contribute 860 lb. The pans operate at 58 r.p.m., grind a trifle less than 20 tons per day, and consume 8.4 hp each.

Mercury is fed in small quantities to the pans, and the pulp, after overflowing the pans, passes over amalgamating plates, one plate, 4 ft. 6 in. wide and 6 ft. long, being provided for each pan.

These plates are dressed twice daily, and the amalgam is removed on alternate days; the pan is cleaned up when new dies and mullers are to be installed, usually about once in three weeks.

The tube mill, driven by gearing from an electric motor, and provided with a scoop feeder, is lined with silex blocks, formerly 3 in. and now 5 in. thick. Flint pebbles are used for grinders, experiments with ore having proved unsatisfactory.

The pulp fed to the tube mill is diluted with sufficient water to carry it freely through the pipes into which the concentrating cones discharge, and is delivered into a dewatering cone, 3 ft. 6 in. by 70 deg. slope, which is mounted above the feed hopper of the tube mill. The thickened pulp discharged from this cone carries fully 62 per cent solids, but it is interesting to note that the cone remains clear of any accumulation of sand, a rod introduced at the top meeting with no resistance until it encounters the bottom of the cone immediately above the bushing.

As this adjustment depends entirely upon the discharge area, it is necessary to frequently renew the bushing, and at this point the life of a bushing is not more than two weeks.

The overflow of the dewatering cone is nearly free from solids, containing but a small quantity of sand, over 90 per cent of which will pass a 200-mesh screen. This is led around the tube mill and unites with the ground sand at the discharge, where it dilutes the pulp sufficiently to carry it over an amalgam table, 12 ft. by 18 ft. of silvered copper.

The mill grinds 73 tons per day, and consumes 37.5 hp when driven at 27 r.p.m.

All pulp discharged from the grinding machines unites with the main stream of pulp before arriving at the second battery of classifying cones.

The pans show a slightly greater recovery of amalgam, but the excessive wear of iron more than offsets all other considerations, and on this account we are preparing to install tube mills for all future work in this department.

The loss of mercury at this plant amounts to 0.061 oz. per ton ground; the amalgam retorts about 26 per cent and has a gold fineness of 630.

The two types of grinding machine have been operated on similar material with a view to determining which is the better

suited for the work, and the conclusion arrived at is in favor of the tube mill. A comparison of the work done shows the pan to be more economical of power, but we consider, and experiments have shown, that if 30 per cent to 40 per cent more sand were fed to the tube mill, and the discharge elevated and returned to classification system, the tube mill would be at least equal to the pan in this respect.

The daily performance of the tube mill and pans is determined by timing the filling of a 5-gal. bucket (⅔ cu. ft.) and weighing the catch. Wherever possible the tipple is used for diverting the flow to the sampler. Suitables have been drawn up so that the tons per day and the water ratio can be read at a glance from these data. The readings are made twice a shift and averaged.

Assay samples of the feed to the pans and tube mill are taken with slotted-top hand samplers, and are used for assay and sizing tests. Similar samples of the ground product are taken from the tipple discharge, which prevents contamination from amalgam plates. Three samples of 1.5 A. T. each are taken for assay.

Tin

Cornish Tin Dressing and the Vanning Assay.—New light is thrown on Cornish tin dressing practice and the use of the vanning shovel, in a paper by W. Fischer Wilkinson published in *Bulletin* No. 99, Inst. Min. & Met. The author presents data obtained during two years' residence in Cornwall as principal of the School of Mines, during which time he was enabled to see what was being done in the mills of the district, as well as to investigate certain problems in the mill which is run for the benefit of the students.

Cornish mines and mills are weak as to statistics. The units adopted, namely, "black tin," "pounds of concentrate per long ton," etc., are indefinite, unreliable and ambiguous. The use of the vanning assay further complicates the situation and clouds the actual conditions. It is only since the introduction of the chemical assay that the serious losses in concentration have been made apparent. It has been generally stated that mill recovery was in the neighborhood of 90 per cent, with additional saving in the stream works, but the author comes to the conclusion that the actual extraction of tin throughout Cornwall today is between 50 per cent and 60 per cent. This great reduction is due to the abandonment of the vanning shovel and the substitution of the chemical assay.

The author gives comparative tests between the vanning shovel and the chemical assay on five different lots of ore and concentrate of varying grades. The results by the former method indicate from 22 per cent to 95 per cent of the tin shown by the chemical assay, and the highest figure was obtained by vanning high-grade, coarse cassiterite. The shovel seems to be least reliable on low-grade material. The figures show that on Cornish tin ores averaging from 1 per cent to 2 per cent tin, the vanning shovel will be about ⅓ below the real value, and that mill extractions calculated on this assay will be in error to that extent. Thus a mill that shows a recovery of 85 per cent by the vanning assay will in reality be making a recovery of about 56.6 per cent.

Examples are given of the work of two companies that give publicity to their technical results. The Cornish Tailings Company, retreating an old dump containing 17 lb. tin per long ton, saves 40 per cent in a modern plant. The Carn Brea & Tincroft Mining Company recovers 95.81 per cent by vanning assay, equivalent to 73.7 per cent by the chemical assay. This is considerably higher than the other mines appear to recover.

The author believes that the first step in improving the recovery is to keep accurate statistics of the value of the ore; to abandon the vanning assay as well as the practice of reporting the yield in "black tin." Proper attention to statistics would show where the greatest loss was being made, and would indicate the direction for improvement.

The practice at the King Edward mill of the School of Mines was to crush in stamps through 4-mesh battery screen, running the pulp over a Buss table where 42 per cent of the metal was recovered in the form of a concentrate containing 32 per cent tin. The first-class middling from this table was screened, the oversize being reground and combined with the undersize for classification. The second-class middling was screened, the oversize being thrown away and the undersize sent to the classifier. The slime and fine sand also were classified. The practice of tabling removed a valuable concentrate and relieved the classifier of 15 per cent of the original weight of ore and 42 per cent of its valuable metal. The coarse product from the classifier was treated on a Frue vanner and the fine on a round table. The tailings of both these machines were retreated.

The author believes that the use of screens such as the Callow of Bunker Hill would permit the immediate rejection of much worthless material, as experiments showed that the undersize of such screening contained a high percentage of the metal. The mill returns compiled from the battery sample and the tin sold during the period 1910-12, gave a recovery of only 50 per cent. He shows from the test figures that there is much room for improvement.

Recent Metallurgical Patents

Iron and Steel

Unmagnetizable Steel.—A patent for an unmagnetizable manganese-titanium steel of Friedrich Kohlhaas covers about the same composition as his German Patent 231,499 of Nov. 13, 1909, viz., a steel containing from 9.8 to 10.3 per cent of manganese, 0.9 to 1 per cent carbon, 0.2 to 1.4 per cent titanium, 0.8 per cent silicon, and maximum 0.03 per cent sulphur and 0.015 per cent phosphorus. The German patent gives the silicon as 0.4 to 0.7 per cent. Steel of from 10 per cent on of manganese has a very low magnetic permeability; it can be magnetized only with extraordinary difficulty, being practically unmagnetizable. Such steel, however, is known to be too hard for being worked and its toughness is too low, the elastic limit being situated pretty near the breaking point. It has been found that this same steel can be successfully produced by adding to it an admixture of titanium in the above named proportions. The new product can be treated with comparative ease; its elastic limit is 47 per cent of its breaking strength, it is less magnetizable than pure nickel and cobalt, and it will lend itself more readily to the various uses of unmagnetic material. (13,440, reissued July 9, 1912; original 981,575 of Jan. 10, 1911.)

Gas Washer.—Mr. Mark W. Johnson, Jr., of Birmingham, Ala., has designed a new gas washer based on the idea of mixing the gas with a tangentially introduced spray of water and leading this whirling mixture of gas and vapor under and in close contact with a thin sheet of water streaming down the outer surface of a flaring nozzle. Water and gas then receive a strong centrifugal action in a circular ring chamber by means of which the outer stratum of water containing the concentrated impurities, such as dust, cinder, etc., can be diverted onto a hopper and from here to a separator. The cleaned gases bubble up through the center of the device and can be carried off. The separator has a suitable drain opening for blowing off mud and a port through which another part of the cleaned gas flows into the pipe line for use. The first named water spray is produced by a needle valve, which is described, together with the other details of the invention, in six special drawings. (1,034,463, Aug. 6, 1912.)

Various Furnace Constructions

Crucible Furnace.—The following arrangement of burner for heating a cylindrical crucible furnace with either gas or a liquid hydrocarbon, is claimed by David Reisinger Steele, of Curtis Bay, Md. Near the bottom of the cylinder is a housing projecting laterally from the cylinder to be used as a combustion chamber. It forms a passageway which communicates tangentially with the furnace chamber. A burner is arranged so as to direct the burning gases or the atomized liquid fuel crosswise or transversely into this passageway, the air entering through another pipe at right angles to the flame issuing

from the burner. The air thus delivered will mingle with the burning gases, divert them from their course and carry them into the furnace chamber. Owing to the tangential arrangement, they will be caused to whirl around the crucible on their way to the top of the furnace. In the case of liquid fuel a branch of the air pipe is connected to the burner in order to produce a spray of the combustible. The furnace can be mounted on trunnions and the pipes connected through a swivel joint to the stationary pipes. (1,020,090. June 11, 1912.)

Air-Cooled Open-Hearth Furnace.—Mr. HENRY KNOTH of Monterey, Mexico, designs a series of spaced air passages which extend transversely and in a straight line through the port arch of open-hearth furnaces. The ends of the passages are left open to have them visible from the furnace floor. The circulation of air through these passages is controlled independently, and in a number of claims it is described how these passages can be connected with each other and with inclined passages leading in various ways, as, for instance, from the front and rear walls upwardly to the side walls of the gas port. A metallic lining is inserted into the inclined portion of lower passages and the circulation of a cooling medium forced through. (1,044,788, Nov. 19, 1912.)

Eyesight Plate for Twyers.—The eyesight glasses in the peepholes of blast furnaces mostly become dirty and fouled and are exposed to the high heat of the furnace. Mr. JAMES B. ROGERS of Ashland, Ky., overcomes this trouble by fastening to the cap of a twyer a rotatably mounted plate provided with a number of holes of the same or larger sizes as the peephole in the cap. Glasses can be inserted into the holes of the plate. By rotating this plate or shutter, the peep sights or glasses, or the larger opening can be brought into or out of register with the opening in the cap or furnace member. If necessary, the same holes can be used for introducing through same a pyrometer or pipes for gas, steam, etc. The invention is equally suitable for all kinds of furnaces in which it is necessary or desirable to have a peephole. (1,04,189, of Nov. 26, 1912.)

Hydrocarbon Furnace.—Mr. JOHN C. SCRIVNER of Madison, Ill., claims the construction of an oil heating furnace into which the burner is introduced from one side near the bottom. While other furnaces mostly have a fire bridge built on the bottom of the furnace, the peculiarity of this invention consists in the roof and side walls of the furnace being slotted, the slots being disposed downwardly and forwardly toward the burner. A removable bridge wall extends through these slots from the top toward the burner, and ends in close proximity thereof, somewhat above the body portion of the furnace bottom. This bridge wall can be a metallic one. The arrangement of the bridge wall under an angle is supposed to distribute the heat more evenly. (1,003,522, Sept. 19, 1911.)

Reversing Valve.—Mr. HARRY BURNLEY ROSE of Johnstown, Pa., claims the invention of a new style of something similar to the Forber valve. One of the advantages of his swinging, oscillating type of valve is that it possesses means whereby it may rest and be shifted from one position to another by mechanism which will be submerged in the water-seal when the valve is seated, and thus be protected, while the operating mechanism is entirely accessible and exposed to view on the outside of the hood. This facilitates ease and economy of maintenance and operation. Furthermore the valve can be easily withdrawn and another one substituted without delay, thereby obviating and shortening in time the strenuous labor under the influence of intense heat and noxious gases. (1,045,749, Nov. 26, 1912.)

Mr. E. A. Grönwall, of Ludvika, Sweden, who is well known also in this country, was married on January 27 to Miss Märta Rydberg of Stockholm. Mr. Grönwall, jointly with Messrs. A. R. Dindblad and O. Stalhane, started the experimental work on the smelting of iron ore in the electric furnace, which was later taken up by the Jernkontoret and led to a new electrometallurgical industry in Sweden and Norway.

Producer Gas as a Substitute for Oil for Furnace Work.

The constantly increasing price of fuel oil, coupled with the assurance of the oil companies that such oil will never again be an economical proposition for commercial fuel purposes has brought both producer gas and the use of coal dust prominently to the front as economical and efficient methods of manufacturing a substitute for oil for all operations where high and low heats are essential.

The use of coal dust is noted in a separate article. In this article some interesting figures are given on the use of producer gas for furnace work as made by the Loomis-Pettibone gas producer, built by the Power & Mining Machinery Company, of Milwaukee.

The Loomis-Pettibone system manufactures a clean, fixed gas from bituminous or anthracite coal and coke, and, in addition, wood and other refuse containing carbon may also be gasified.

In the Loomis-Pettibone system a water gas containing 250 to 275 B.t.u. per cubic foot is manufactured intermittently with the production of a lean producer gas, containing from 90 to 105 B.t.u. per cubic foot. The water-gas can be used for all purposes where high temperatures, without regeneration, are necessary, as in manufactories carrying on a large variety of brazing, small forge work, etc., where the furnaces are small, and distributed over a large area. Temperatures ranging from 2500 to 2900 deg. Fahr. are easily obtainable with this gas, and with properly constructed furnaces, it is possible to contain an added efficiency in operation so that the quantity of B.t.u.'s in the gas used will be only 66 to 80 per cent of the B.t.u.'s furnished in oil as used in approved oil furnaces for the same purposes.

Water-gas does not cause the metal forged to scale like oil, and with it it is possible to get much closer regulation of furnace temperatures.

By mixing a small portion of the water-gas produced with the lean producer gas, a mixed gas of from 125 to 135 B.t.u. is obtained, which gas may readily be used for operations such as annealing, tempering, case-hardening, babbitting, and all such purposes, where temperatures to be obtained do not exceed 1700 deg.

One long ton of good bituminous fuel when gasified by this system will generate 40,000 cu. ft. of water-gas and 120,000 cu. ft. of producer gas, as described above, and there are installations in daily operation which exceed these figures as to output.

If conditions are such that it is possible to install gas engines, part of the lean producer gas can be used to furnish power.

In cases where it is impossible to make use of the producer or mixed gases of the Loomis-Pettibone system, where the heats required are all at high temperatures the Power & Mining Machinery Company recommend their blue water-gas apparatus, operating on anthracite coal and coke. This apparatus makes a water-gas containing 300 B.t.u. per cubic foot from the fuels specified above, and, when equipped according to this system with high-pressure blower, steam drying and distributing apparatus, quick-operating valves, etc., will produce 50,000 to 60,000 cu. ft. of such gas per ton of fuel gasified when operated properly according to instructions. This gas possesses all of the qualities of the water-gas made in the Loomis-Pettibone apparatus, and, in addition, has a higher heating value per cubic foot.

In the present note it was merely intended to give figures of the results obtained in commercial practice in order to provide a basis for estimating the possibilities of gas in competition with crude oil. As to the description of the construction of the Loomis-Pettibone Gas Producer and Blue Water-Gas Plants reference may be had to Bulletin 106 of the Power & Mining Machinery Company, of Milwaukee, which is entitled "Loomis-Pettibone Gas Generating System, Gas for Furnace Work."

Pulverized Coal as a Fuel

By A. W. Raymond

The recent increased cost of crude oil has turned the attention of fuel oil users on pulverized coal as a substitute, instead of reverting to the old producer gas plant, and experiments which have been carried on along these lines have demonstrated not only its adaptability and efficiency, but also its economy. When properly pulverized coal will yield higher temperatures and more B.t.u per ton than can be obtained from a like amount of coal used in a producer gas plant while the equipment is about one-third the cost.

The method of burning the coal dust is very simple. A pipe conducts a blast of air into the furnace and the coal dust is automatically introduced into the air at a point about one foot from the nozzle of the pipe. Any method of feeding the coal, such as a screw conveyor, which will insure a regular and uniform feed will be found satisfactory. The temperature in the furnace and the length of the flame is very easily controlled by the velocity of the air blast and the quantity of coal dust mixed with it. In order to get complete combustion of the coal to carbon dioxide the mixture of air and coal dust must contain at least four times the calculated amount of oxygen required.

For the benefit of those readers who are in doubt as to the adaptability of coal dust as a fuel, the writer would like to say that to his personal knowledge pulverized coal has been burned successfully for the last ten years in a number of large plants. Among these plants are the Canadian Copper Co., at Copper Cliff, Ont., Canada, where powdered coal is burned in the smelting furnaces, and the Chicago and Hamilton, Ont., plants of the International Harvester Co., who use it as the source of heat for their annealing ovens. These plants pulverize the coal to such a degree of fineness that 98.5% of it will pass through a 100-mesh sieve.

The writer has also recently had occasion to come in personal contact with some experiments on a regenerative open-hearth furnace. Two heats of open-hearth steel have been made with powdered coal as a fuel and very even and high temperatures were maintained with coal pulverized so that 91% would pass a 200-mesh test sieve. The checkers showed no sign of plugging and the steel was as free from sulphur as when producer gas or fuel oil is used. For these tests the coal was ground on a pulverizer depending on screens to get a fine product and it was clearly demonstrated that the cost of grinding the coal to the necessary degree of fineness on this type of machine was prohibitive, so the reader can deduce that all that is needed to make the use of pulverized coal a regenerative type of open-hearth furnace a success is a method of pulverization which will yield a product as fine, or, better still, even finer than 91% through a 200-mesh test sieve.

The knowledge which has been gained from investigation, experiences, and comparative tests shows the Raymond four-roller mill, fitted with what the Raymond people call their vacuum air separator, to be an excellent method of pulverization which will answer the purpose. Averaging these tests which cover a period of over a year's time on fourteen pulverizers, the cost per ton of pulverizing the coal so that 99.5% will pass a 100-mesh test sieve amounted to $0.325. This figure includes the power used at a cost of 1.5 cents a kilowatt hour and shows a saving of $0.211 per ton over any other method with which it was compared. Though the above tests only proved the necessity of a finely pulverized coal on a regenerative type of furnace, the writer holds to the belief and feels confident that the reader will agree with him that the highest efficiency in any or all cases can only be obtained when the coal is ground extremely fine and uniform. Let us now take up the process of properly preparing the coal for the burners step by step:

The coal must first be crushed so that it will all pass through a ring 1¼" in diameter, as there is no machinery made which will reduce the ordinary mine run of coal to the required fineness in one operation. Though not absolutely essential, it is generally conceded that the crushed coal should be dried thoroughly before pulverizing or burning, as dried coal can be pulverized with 15% less horsepower than the wet, and it is almost axiomatic to say that dried coal is more easily ignited and consequently gives higher temperatures and less ash. Actual experience has proven that drying the coal before pulverizing or burning it is a money saving practice. Excellent drying apparatus is manufactured by the Ruggles-Coles Engineering Co. After the coal is thoroughly dried it is ready to be fed into the pulverizer and the necessity of using the right kind of pulverizing machinery cannot be too strongly emphasized.

The pulverization of coal entails no danger from spontaneous combustion, providing the necessary precautions are taken. The pulverizer used must be one which does not heat up the coal; that is, one in which the friction is reduced to a minimum, and the danger of sparking against any iron in the coal is eliminated. A ball mill is unpractical because the pusher plates behind the balls get very hot and will invariably cause the coal to take fire.

The first step is to select a pulverizer which delivers a cool product so that it can be safely stored for a day or two. Investigation will show the Raymond mill, before referred to in this article, to be such a pulverizer. This mill has another very important advantage in that the coal is never allowed to settle in the grinding chamber and for this reason the danger of an explosion in the pulverizer is entirely eliminated. These mills have been grinding coal in the United States and Canada for the last ten years and there is no record of any explosion or fires in, or resulting from, them. There is also another point to consider in the selection of a pulverizer.

The efficiency of combustion depends entirely upon the degree of pulverization. In other words, the finer the degree of pulverization the more economical the operation, the higher the temperature obtained and consequently a low percentage of a finely divided ash. In a regenerative type of furnace a low percentage of ash in a very finely divided state is absolutely essential, as anything else would clog up the checker work. Therefore, the coal must be pulverized very fine, the degree of fineness being determined by the cost of grinding as this cost must be kept as low as possible in order to make a powdered coal burning installation more economical than a producer gas plant. Here again we find the Raymond mill peculiarly adapted to coal grinding. The capacity is not limited, as in the case of a screen pulverizer, to the capacity of the screens, but every atom of power put into the mill is used in grinding the oversized coal, as the pulverized coal is removed immediately by the vacuum air separator. This principle is the very essence of economy as there is no waste of power.

Not only must the coal be very fine, but it must also be very uniform. Nothing but a very uniformly pulverized coal will maintain the steady and even temperatures which are required in almost every case. Particles of coal too large to pass an 80-mesh mean a resultant ash which contains a great many unused British thermal units, consequently, economical operation requires a very uniform degree of pulverization, which is impossible to obtain in a screen machine. A test made in the coal house of the Huron Portland Cement Co.'s plant at Alpena, Mich., and covering a period of six days showed that the coal ground on Raymond mills did not vary more than 0.2 in the percentage which passed a 100-mesh test sieve; in other words, the coal was ground so that never less than 98.4% or more than 98.6 % would pass a 100-mesh test sieve.

The next question is, what is the cheapest method of pulverizing? In the writer's opinion the following figures obtained from the Omega Portland Cement Co. speak for themselves. These figures are averaged for a year's time and the coal was ground so that 98.5% would pass through a 100-mesh test sieve. In the one case the coal was ground in a Raymond mill and in the other it was pulverized in a hammer cage mill and finished on a tube mill. The cost of operation and repair, not including power, on the hammer cage and tube mill com-

bined was $0.336 per ton, while on the Raymond mill only $0.125 per ton, and the power required on the Raymond mill per ton of coal ground was a little less than half that required for the other method. Other tests comparing the Raymond mill with a ball mill used in the place of the hammer cage have substantiated the above figures.

The use of the Raymond mills in other large cement plants has resulted in a saving of two-thirds the labor and an increase of 12% in efficiency of combustion due to the high percentages of impalpable powder which is obtained by the Raymond system. One cement plant was able to make 13,500 tons of coal ground on Raymond mills, burning the same amount of clinker, as 15,120 tons ground by a different method would burn.

In brief, then, the installation for properly preparing the coal most economically should consist, in the writer's opinion, of gyratory crushers, Ruggles-Coles dryers and Raymond roller mills with vacuum air separators.

A New Electric Speed Indicator and Recorder

The Brown Instrument Company and the Keystone Electrical Instrument Company of Philadelphia, Pa., are placing on the market a new electric tachometer or speed indicator to accurately indicate, or record on a chart, the revolutions per minutes of a rotating shaft or wheel.

There are many operations where an accurate speed indicator is desired to be permanently connected to an engine or machine, and to show at a glance the speed at which it is running, or

FIG. 1.—ELECTRIC SPEED INDICATOR

to keep a constant record of this speed on a chart for the whole 24 hours.

The electric tachometer has the advantage of not only being exceedingly accurate, but that the indicating or recording instrument can be located at any desired distance from the shaft, the speed of which is to be measured. The instrument consists of a small generator, particularly designed for use with this tachometer. It generates 25 volts at 1000 revolutions per minute. On account of the voltage generated, an instrument, absolutely dead beat in operation, can be supplied. Instruments have been particularly designed by the above companies of unusually high resistance, exceeding 3000 ohms in each instrument, so that the length of leads connecting the magneto or generator and the indicating instrument have no effect on the readings. For the same reason one, two or three instruments can be connected to the same generator without affecting the indications. This high resistance feature is exceedingly advantageous, for oftentimes after the generator and one indicating instrument have been installed, it is desirable to place a recording instrument in the office, or at another convenient point, and this can be connected to the generator without recalibration of the instrument.

In Fig. 1 is shown the standard Brown electric tachometer

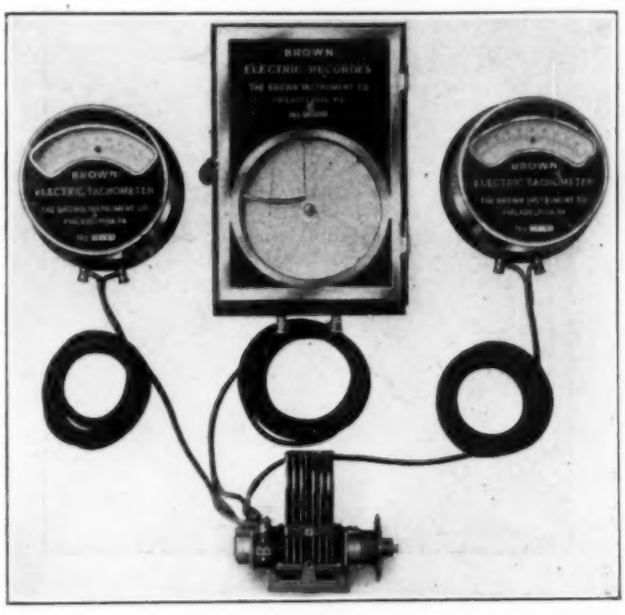


FIG. 2.—GENERATOR WITH TWO INDICATING AND ONE RECORDING INSTRUMENTS

generator, leads and indicating instrument as usually supplied, while in Fig. 2 is shown a group of instruments connected to a generator driven by sprocket and chain, two indicating instruments and one recording instrument being connected to the same generator to both indicate and record the speed at three different points.

With many machines it is desirable to operate them at a certain speed to produce the best results, as for instance, in large machine tools it is desirable to know the cutting speed, and by use of this electric tachometer mounted beside the machine the exact speed can be noted at all times, and maintained as desired.

At all blast furnace plants where gas or steam blowing engines are in use it is necessary to run these engines at a constant speed so that a certain number of cubic feet of air per minute can be blown into the furnace. The revolutions per minute in cases such as this are of exceedingly great importance, and with the Brown electric tachometer with one indicator mounted near the blowing engines, on the engine itself, or on a switchboard nearby, and with a recording instrument if desired in the Master Mechanics' office, a perfect regulation and record of the speed can be secured.

There are many tests which constantly have to be made where an electric tachometer of this character will prove particularly advantageous. As an instance, we might cite the locomotive tests which are run by several universities and larger railroads which have testing departments in which the speed of the driving wheels can be readily determined.

Another use of this electric tachometer is on war vessels and merchant ships where it is particularly desirable not only to indicate the speed of the propellor shaft in the engine room, but also frequently at the same time in the chart house and on the bridge.

A bulletin on this new electric tachometer which has some radically improved features may be obtained from the manufacturers.

A New Temperature Recorder

At the New York Automobile Show which closed last week we had the pleasure of making the acquaintance of a temperature recorder of striking novelty. It is built by the Leeds & Northrup Company, of Philadelphia.

While it is new in so far as it has not been described before, yet it has been in use in various plants under quite different conditions in order to test it thoroughly in practical use. The development of the instrument covers more than five years. A large number of models was made and rigorously tested. In

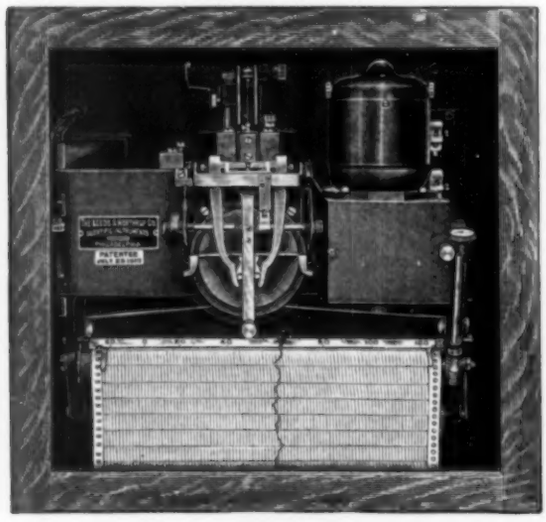


FIG. 1.—TEMPERATURE RECORDER

addition to tests of complete instruments, every important part was subjected to prolonged tests for wear and other objectionable features. In addition to tests in their own laboratory the Leeds & Northrup Company had a number of instruments of each type in operation in the shops of large steel mills and in other works where they could be watched under such exacting conditions as are associated with temperature measurements. The National Bureau of Standards used one of these recorders on shipboard of the scout cruiser *Salem*. The instrument in question was sensitive to 0.05 deg. C. and proved perfectly satisfactory. If memory serves us right, the boat in question is considered one of the shakiest in the navy.

One striking novelty of the design is shown in the outside appearance of the apparatus in Fig. 1. It is the fact that the whole mechanism of the recorder is exposed to view and inspection. The whole apparatus consists of standard parts. These parts are in general of dimensions and strength comparable to the parts of a sewing machine. The design is such that each part may be removed and replaced easily. If necessary, a recorder could be entirely dismantled and reassembled with the aid of two screwdrivers and two standard wrenches. If a part is damaged a duplicate standard part can be inserted. These recorders have been developed to take down a single curve or several curves at the same time. In this article we deal with the single-curve recorder only.

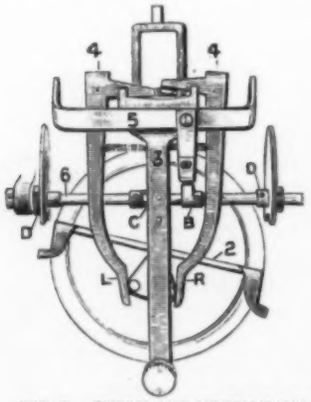


FIG. 2.—DETAILS OF MECHANISM

These recorders can be used either with resistance thermometers or with thermocouples. If the recorders are used with a resistance thermometer the connections are those of a Wheatstone bridge. If the recorder is used with a thermocouple the connections are those of a potentiometer.

In these recorders the automatic balancing of the galvanometer of Wheatstone bridge is accomplished in the manner shown in Figs. 2 and 3. The motor drives the shaft (6) through a worm and gear at a speed of about 30 revolutions per minute. The shaft carries four cams (6*B*), (6*C*), (6*D*), (6*D'*), so located on the shaft that at the same time that (6*B*) raises the rocker arm (5), (6*C*) carries the clutch arm (2) away from the clutch disk (1).

The galvanometer, except at periodic intervals, swings freely about the location shown in Fig. 3. When the galvanometer is balanced the pointer lies at the position shown in Fig. 3, and as the rocker arm (5) is raised it lifts the pointer into the space between the two levers (4*R*) and (4*L*). If, however, the galvanometer is unbalanced, the resultant movement is shown in Fig. 2, the one lever or the other being lifted due to the interposition of the pointer between the lever and the rising rocker arm. The wings on the clutch arm can clear the cams 6*DD'* only when the clutch arm is horizontal, consequently, after being set as in Fig. 1, subsequent rotation of the shaft (6) returns the mechanism to the position shown in Fig. 3. When the

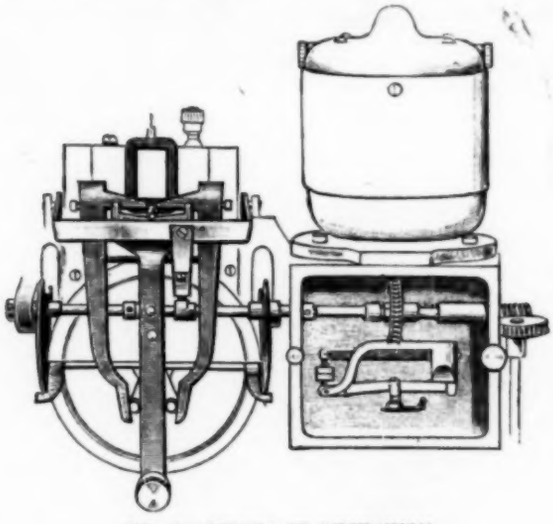


FIG. 3.—DETAILS OF MECHANISM

clutch arm is being tilted it is free from the disk; when it is returned it is in engagement with the disk and the two turn together.

Mounted on the disk shaft is the circular slide resistance. Also there is present on the shaft a wheel for communicating all motions of the shaft to the pen or print-wheel making the record. The movement of the disk, as described above, is always in such direction as will tend to restore a balance in the potentiometer or bridge circuit and the amount of movement is approximately proportional to the deflection of the galvanometer.

A pamphlet giving further details of the instrument may be had from the manufacturers.

International Commission on Annual Tables of Constants

The following gentlemen have agreed to serve on the American Advisory Committee of the International Commission on Annual Tables of Constants:

Dr. W. D. Bancroft, Dr. Carl Barns, Dr. A. L. Day, Dr. A. A. Michelson, Dr. W. A. Noyes, Dr. Ira Remsen, Dr. Jos. W. Richards, Dr. Theo. W. Richards, Dr. Alexander Smith, Dr. S. W. Stratton, and Dr. W. R. Whitney.

The first volume of the Annual Tables of Constants appeared last year and a review of it was published on page 572 of our volume X. The second volume will be out in the near future.

Special Mixing and Grinding Machinery

The adjoining four illustrations show several mixing and grinding machines with various novel features.

Fig. 1 is a view of a special mixing machine designed for handling a pulpy mass. The machine illustrated had an extra special feature, as it was one of several designed and built for

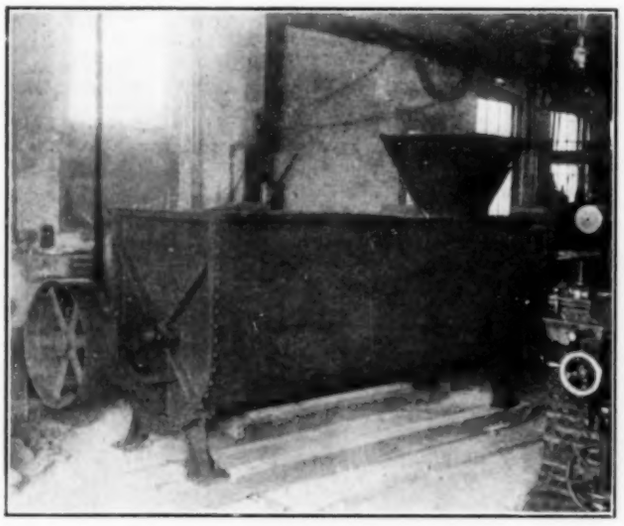


FIG. 1—SPECIAL MIXING MACHINE FOR A PULPY MASS

handling a material which should not come in contact with iron, copper, steel, etc. These machines were constructed very heavy, water-tight in every respect, and all parts that could come in contact with the product were very heavily coated with tin.

The machines were equipped with special stuffing boxes, had bronze bushings in the bearings, and were equipped with quick-discharge valves of a special type. All surfaces were free from projections, so that they could be kept perfectly clean. These machines were approximately 30 in. in diameter by 7 in. long. They were sold with a guarantee of 1500 gal. capacity per hour, but actually produce 3000 gal. per hour each, with the use of 50 per cent less horsepower than guaranteed.

A Special Built Ball Grinding Mill

Figs. 2 and 3 show the first ball-grinding mill built with a seamless steel shell. This machine is really the regular type

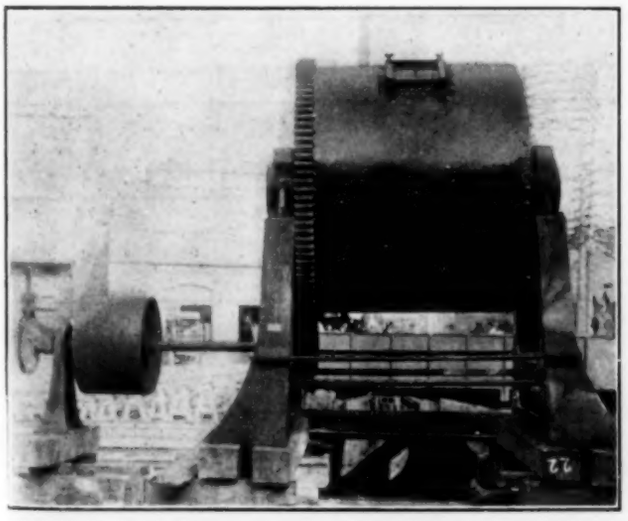


FIG. 2—BALL GRINDING MILL

of pebble mill with the exception that instead of using pebbles for producing the grinding and mixing action, metal balls were used as the material to be handled is of a fluffy nature, and at the same time has an inclination to become sticky. For this reason it was necessary to have the machine absolutely smooth inside, without obstruction, so that there would be no possibility of the material adhering to any point.

Fig. 3 shows the machine surrounded by a dust-proof discharge casing, which was made practically air-tight, so that either cold air could be circulated between the shell of the mill

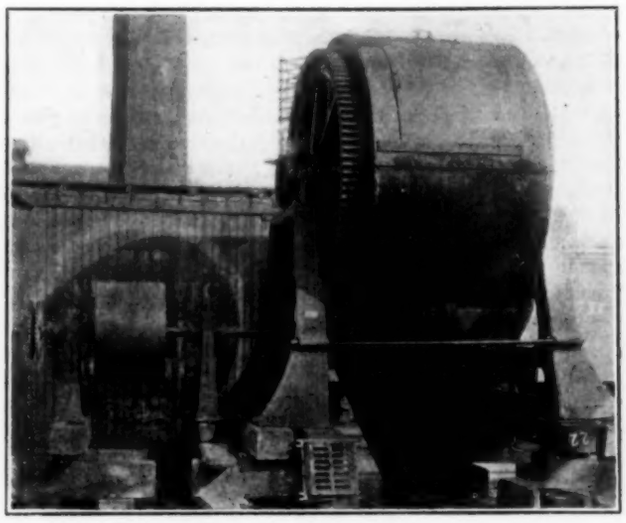


FIG. 3—BALL GRINDING MILL WITH DUSTPROOF DISCHARGE CASING

and the casing or cold water could be run through the pipes surrounding the machine proper in order to keep it cool. The cylindrical part of the machine is 6 ft. diameter by 5 ft. long. The shipping weight was 18,000 lb. Its relative size can be seen by comparing it with the freight car standing behind it.

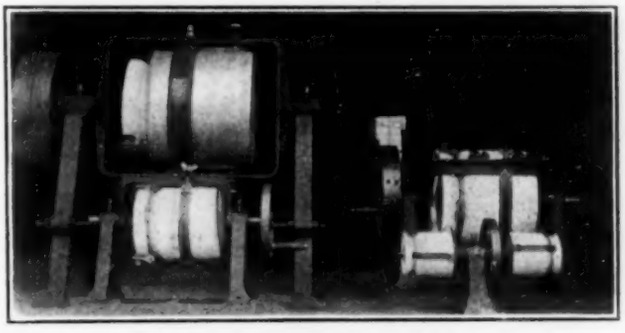


FIG. 4—PORCELAIN JAR MILLS

Fig. 4 shows the relative size of four different types of porcelain jar mills. It also illustrates part of a shipment of this class of machinery made to South Africa several months ago.

All these machines were personally designed by Mr. Paul O. Abbe, of New York City, to meet the special requirements for which they were intended.

The Basket Type Evaporator

For many purposes in chemical engineering the use of the basket type evaporator, developed and patented by the Swenson Evaporator Company, of Chicago, is found to be particularly suitable. The principal feature of this patented type is the inner shell located 1½ in. outside the nest of tubes and providing additional heating surface which results in an increase of 8 or 10 per cent in the evaporative efficiency of the outfit.

The main advantage of this construction is not so much the increased heating area thus made available as the influence of this shell upon the direction and vigor of the circulation. Upon starting up an evaporator of this type, the evaporation from the space between the inner shell and the tubes starts almost instantly, resulting in a shooting up of a ring of liquor from this space long before evaporation begins in the tubes. With a

space for return current of about 8 in. between the inner shell and the outer shell of the evaporator, this type of apparatus has a splendid downward circulation rigidly directed into this space.

Sluggish circulation would be very troublesome in handling heavy or salty liquors, as it would result in incrustation of the pipes, resulting in slowing up the work by diminishing the value of the heating surface and not permitting the same concentration with a given temperature difference.

The matter of steam or vapor circulation *around* the tubes is very important. In the Swenson basket type about 8 per cent of the tubes are omitted in order to provide more generous circulating spaces. In this way the steam reaches all of the tubes as soon as it gets into the basket and both the operation and the wear are much more uniform. This is noticed by the equal evaporation over the entire boiling surface. As particular attention is paid to the removal of non-condensable gases the wearing qualities of the upper parts of the tubes are much increased.

An Interesting Agitator Test in Cyanide Practice.

To Dr. Wilbur A. Hendryx, who recently returned from South Africa, we are obliged for some interesting notes on an official test of the Hendryx agitator on the Rand.

One of the 18-ft. agitators, constructed by Head, Wrightson & Company, Ltd., of London, Eng., who are manufacturers and sales agents of the Hendryx apparatus in foreign countries, was sent down to Johannesburg, and turned over to the Mines Trial Committee of the Chamber of Mines of Johannesburg. This committee is composed of high-class mechanical and metallurgical engineers who represent all the groups of mines on the Rand.

The present general method of treatment on the Rand consists of stamping, amalgamating, tube milling, and classifying, then leaching the sands six to seven days, and treatment of slimes by decantation. A few of the more recent plants have installed agitation and filtration for their slimes. The average extraction as near as Dr. Hendryx was able to ascertain by the above methods, including amalgamation, is from 92 to 93 per cent.

In view of this situation, the results of the official test of the Hendryx agitator shown in the adjoining chart are interesting. They were so satisfactory that the Hendryx agitator was installed at the Wolhuter Gold Mine, which has a capacity of 1,000 tons per day.

It will be noticed from the report that only one charge of slimes, 95½ per cent minus 120 was treated in two hours with 98 per cent extraction. The other four tests were made on the mixed product of sands and slimes, and it will be noticed by the solution assays that six hours was the longest period to get the extraction, and in charges 3, 4, and 5, that it was practically completed in 3 hours.

Taking these facts into consideration and the results on the slimes it appears quite reasonable to conclude that if these ores were ground to minus 90 mesh, 3 hours would be sufficient in which to treat this product. Most of the mills on the Rand to-day are grinding at least 98 per cent to minus 90.

It will also be seen that the percentage in cyanide loss is extremely small and this would substantiate the claim that Dr. Hendryx has always made that the loss of chemicals was far less by the use of mechanical agitators than where air agitators were resorted to, as well as the time of extraction being much shorter, and that it also substantiates the fact that it is practical to treat sands and slimes together.

If the continuous process is adopted, the time for filling and discharging is eliminated, and this method of treatment is receiving serious consideration by the leading engineers on the Rand.

RESULTS OF ACTUAL TESTS MADE BY THE MINES TRIALS' COMMITTEE AT THE WOLHUTER G.M. CO.

Test No. and Date.	1.—March 11, 1912.	2.—March 20, 1912.	3.—March 26, 1912.	4.—April 9, 1912.	5.—May 2, 1912.
Product..	Sands and Slimes.	Slimes only.	Sands and Slimes.	Sands and Slimes.	Sands and Slimes.
Quantity and Ratio ..	Ore: 35 tons / Soln.: 70 ,, } 1 : 2	Ore: 35·03 tons / Soln.: 70·00 ,, } 1 : 2	Ore: 35 tons. / Soln.: 71 ,, } 1 : 2	Ore: 35 tons. / Soln.: 72·4 ,, } 1 : 2·068	Ore: 35·09 tons / Soln.: 73·69 ,, } 1 : 2·1
Grading: + 60	9·4%	—	13·75%	5·93%	9·18%
+ 90	19.3%	·1%	17·74%	20.52%	21·10%
+ 120	11·3%	·4%	10·70%	12· 0%	11·39%
— 120	60·0%	99·5%	57·81%	61·45%	57·33%
Average Assay of Charge ..	2·55 dwts.	1·65 dwts.	2·2 dwts.	1·95 dwts.	2·3 dwts.
Solution Sth per ton of ore— Start	·068 × 2 = ·136	·021 × 2 = ·042	·063 × 2 = ·126	·052 × 2 = ·104	·0525 × 2 = ·105
Finish	·066 × 2 = ·132	020 × 2 = ·040	·060 × 2 = ·120	·050 × 2 = ·100	·050 × 2 = ·100
Loss	·002 × 2 = ·004	·001 × 2 = ·002	·003 × 2 = ·006	·002 × 2 = ·004	·0025 × 2 = ·005
Extraction :—By Solution.	Assay × Ratio. dwts.	dwts.	dwts.	dwts.	dwts
1 hr	·76 × 2 = 1·52	½ hr. ·5 × 2 = 1·0	1 hr. ·67 × 2 = 1·34	1 hr. ·6 × 2·068 = 1·24	·57 × 2·1 = 1·218
2 hrs.	1·00 × 2 = 2·00	¾ hr. ·58 × 2 = 1·16	2 hrs. ·83 × 2 = 1·66	2 hrs. ·67 × 2·068 = 1·385	·65 × 2·1 = 1·365
3 hrs.	1·10 × 2 = 2·20	1 hr. ·69 × 2 = 1·38	3 hrs. ·84 × 2 = 1·68	3 hrs. ·68 × 2·068 = 1·406	·79 × 2·1 = 1·659
4 hrs.	1·15 × 2 = 2·30	2 hrs. ·76 × 2 = 1·52	4 hrs. ·9 × 2 = 1·80	4 hrs. ·79 × 2·068 = 1·633	·85 × 2·1 = 1·785
5 hrs.	1·15 × 2 = 2·30	3 hrs. ·76 × 2 = 1·52	5 hrs. ·92 × 2 = 1·84	5 hrs. ·84 × 2·068 = 1·737	·89 × 2·1 = 1·869
6 hrs.	1·20 × 2 = 2·40		6 hrs. ·94 × 2 = 1·88	6 hrs ·84 × 2·068 = 1·737	·98 × 2·1 = 2·068
7 hrs.	1·20 × 2 = 2·40				
% Extraction by KCy. Solution.	2·4 dwts. from 2·55 = 94·1%	1·52 dwts. from 1·65 = 92%	1·88 dwts. from 2·2 = 85·4%	1·737 dwts. from 1·95 = 89·3%	2·068 dwts. from 2·3 = 89·47%
Washed Residue Assay ..	·281 dwts.	·05 dwts.	·35 dwts.	·25 dwts.	·55 dwts.
Comparative % Extraction from— Residue Assay	93·06%	97%	84%	87·2%	76·3%
Solution Assay	94·1 %	92%	85·4%	89·3%	89·47%

The above figures represent the exact results obtained by the Mines Trials' Committee (Johannesburg Transvaal) in the Hendryx Agitator upon residues after Amalgamation.

The Following Figures show the total Extraction from the Original Ore, including Amalgamation in the Mill and were Furnished by the Courtesy of the Wolhuter G M. Co.

Total Extraction : by Amalgamation and KCy Solution—					
Figured from Residues	97·6%	99·0%	94·5%	95·5%	91·6%
Figured from Solutions	97·9%	98·0%	94·89%	96·2%	96·31%

The First Combination Induction Furnace in Operation in the United States

By C. H. Von Baur

It was the desire of the Crucible Steel Casting Co. of Lansdowne, Pa., to be up-to-date in making steel for small and intricate castings, which prompted them to adopt an electric furnace.

The type selected is the Roechling-Rodenhauser induction furnace and the eighteenth to be placed in operation. Since then four additional R.-R. furnaces have been ordered by other steel mills. This one, the first to be placed in operation in this country, has a pouring capacity of 2 gross tons and

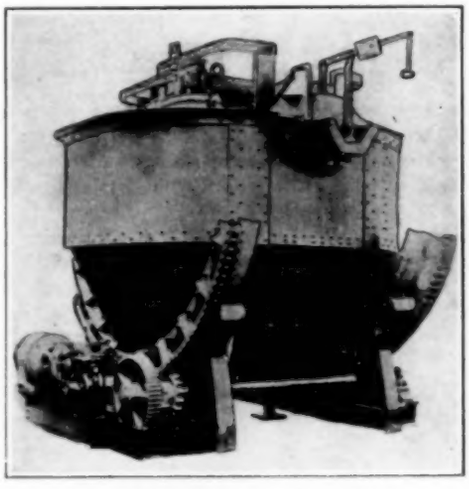


FIG. 1.—2-TON, 300-KW. ROECHLING-RODENHAUSER ELECTRIC INDUCTION FURNACE (FRONT VIEW)

operates at 300 kw from a 25-cycle, single-phase, 480-volt, 75 per cent power factor alternator, driven by a two-cylinder De La Vergne oil engine. This prime mover was decided upon, as it burns not only the heavy Mexican oils 16 to 19° Beaumé, but also the less expensive water gas tar. When running to capacity on single turn (12 hours), the furnace receives its electricity at not over 0.7 cent per kw-hour. The local lighting companies' price for current was more than twice as high as the above rate.

The furnace is 200 feet from the alternator. In order that the heat regulation might be accomplished within sight of and reasonably near the furnace, a remote control switchboard was erected about 30 ft. in front of and slightly higher than the spout. From this platform the furnace heat may be raised or lowered by pressing a button or shut off altogether by similar means. There is also here the controller which operates the motor for tilting the furnace. Electric instruments at both switchboards show at all times the degree of heat in the furnace. The blower motor supplying air for cooling the furnace transformer coils consumes 4.95 kw.

The bottom consists of magnesite and tar tamped in with pneumatic rammers. The roof is made of magnesite brick and lasts indefinitely.

The first steel was made in November 18, 1912. Since then a second lining has been put in. This was baked in more carefully than the first, taking about 24 hours at 50 kw. At the end of the fifth day's pour absolutely no sign of wear could be seen in the channels and only a slight scarification in the central hearth. The side walls usually last 3 weeks before thorough repairs are made.

At present it is the object to charge only cold metal, melt it and refine it. Room has been left for a preliminary melting furnace, to be installed when the capacity of the electric with cold charging on single turn has been reached. The furnace has a capacity of 1200 tons annually with cold charging, and 2850 tons with hot charging, both on single turn.

One gratifying point about this type of furnace is that good steel can be made and was made with old open-hearth melters, right from the start, the reason being that the melter could keep his whole mind on making steel, without being distracted by an irregular heat supply, spot heating, frozen corners, or broken electrodes.

One important point in connection with the use of this electric furnace is the possibility of avoiding defective castings. In one run made there were no defective castings which had to be welded with the oxy-acetylene or the electric arc. Several castings have been sawed through and in every case they were found to be free from blowholes. Disregarding for the moment the fact that electric steel in the ladle costs less than crucible, small converter, or even steel made in the open hearth, either acid or basic, there is no doubt a large additional saving effected on account of the defective castings being reduced to a minimum.

Assuming that the molds are always in good condition, there are several causes which enable good castings to be made. *First*, the steel is thoroughly deoxidized and pours as well if not better than the best crucible steel. *Second*, while the steel has any desired temperature it is not "blowy," as converted steel is apt to be, nor do the castings suffer from "heat" or sulphur cracks. *Third*, a thoroughly reducing action is easily obtained toward the end of the heat without reducing the temperature as in the open-hearth.

The results obtained applied to a concrete case will show how great this saving is. A well-known foundry making miscellaneous small and medium size steel castings, bench work, etc., acknowledged the loss of 6% due to some of the above causes.

This foundry poured about 2400 tons annually, of which about 65% resulted in castings. The greater portion being small work, the average price was slightly over 10c. a pound. Electric steel in foundries has been known to reduce the "defects" to one per cent. The possibility of such a foundry adopting electric steel would result in sending 78 tons of castings more from the shipping room with the same output poured, and increase the profit $17,500—a large additional interest on the investment.

An interesting feature when melting scrap in the electric induction furnace, is that the time required for a heat is reduced as the electric energy at the furnace terminal is increased; that is, the shortened melting time raises the attain-

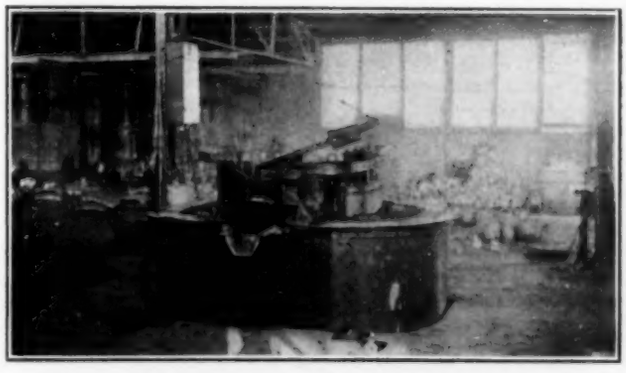


FIG. 2.—VIEW OF FURNACE AFTER ERECTION

able efficiency of the furnace. There is another case of an induction furnace—a one-and-a-half-ton Kjellin—where a mixture of pig and scrap was melted with 966 kw hours per ton over a six-hour melting period, having 166 kw at the terminals, whereas 800 kw hours only were consumed during a four-hour period having 200 kw at the furnace. This gives a total efficiency of 50% for the six-hour melting time, and 60% for the four-hour melt.

In the accompanying figure the upper dotted line shows these conditions and proves the following formula:

$$\text{Tons melted} = \frac{\text{kw at furnace} \times \text{hrs.}}{\text{kw hours per ton.}}$$

The power should be kept at the furnace at a uniform rate.

This brings us to the case under discussion, where with a two-ton furnace a mixture of 1.38 tons consisting almost exclusively of scrap was melted and brought to a temperature as before indicated with 844 kw hours per ton in four hours and fifty minutes, or—

$$1.38\ \text{T} = \frac{241\ \text{kw} \times 4.83\ \text{hrs.}}{844\ \text{kw hours per ton.}}$$

Drawing a parallel line to the foregoing case we reach the point the two-ton furnace has been designed for, namely, to produce 1.5 tons in 3¾ hrs. with 300 kw at the furnace terminals, or—

$$1.5\ \text{T} = \frac{300 \times 3.75}{750}$$

Later on when a preliminary melting furnace of one form or another is installed, the output will be greatly increased, as 275 kw hours per ton will be sufficient to refine and degasify ordinary mixtures of pig iron and scrap. This would give a 10-ton output in 12 hours, greatly decrease the cost for electricity, and for the bottom, per ton of output, and decrease the overhead charges to 45% compared to cold charging.

The quality of electric steel made is the equal of crucible or

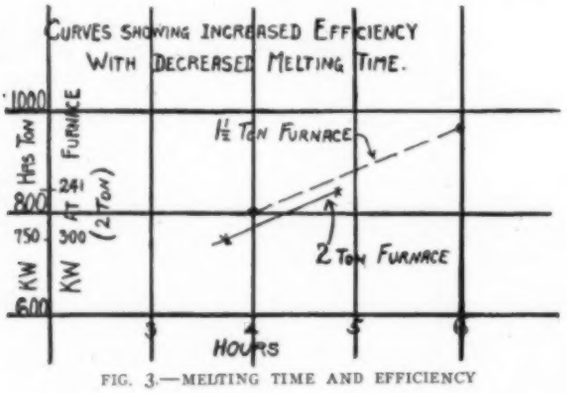


FIG. 3.—MELTING TIME AND EFFICIENCY

better. This high grade of deoxidized steel was made with about the following cost per ton:

Raw material (scrap)	$14.50	
Oxidation loss about 2%	.29	
		$14.79
Current, 844 kw hours, at 7c.	$5.91	
Fluxes	.76	
Ore	.05	
Labor	1.50	
Tools, repairs and bottom	.76	
Cooling air for transformers	.12	
Conversion cost		9.10
Interest 5%, depreciation 10% per ton, about		1.50
Cost of one gross ton electric steel ready to pour		$25.39

When larger amounts of scrap are charged at a time, thus lessening the radiating losses due to the doors being open, and when 280 to 300 kw. is at the furnace instead of 250, the time for melting and deoxidizing will be shortened considerably, and the kw hours per ton reduced to about 750, which is near the European record for similar work in this size and type of furnace, exclusive of the heat required for baking in the bottom, and heating at night on single turn. It required 125 to 130 kw continuously to keep a full charge at temperature.

According to various calculations and tests, the amount of theoretical electrical energy necessary for melting down one gross ton of 2/3 scrap and 1/3 pig iron is given at 489 kw hours, at a tapping temperature. This figure has also been given as 430 kw hours for mild steel when tapping at 1650° C.

The total electrical and thermal efficiency based on the observed radiating losses, with this furnace, is

$$100 - \left(\frac{130 \times 100}{300}\right) = 56.6\%$$

This figure checks up very well with conditions of this heat, which was hot enough, as already mentioned, to melt a 1¼-in. rod in 15 seconds, indicating a temperature well above 1650° C. If 430 kw hours per ton for melting is taken as the correct figuse, no doubt 50 kw hours should be added to this for the additional superheating, which was estimated to be between 100 and 125° C. It takes about 40 kw hours to raise the temperature 100° C. Consequently

$$\frac{480}{844} = \text{approx. } 56\% +$$

The operation of this electric induction furnace, both economically and practically, is eminently satisfactory. For the past 12 years a Kjellin induction furnace has been in operation making tool steel, where its field in displacing the crucible is limited. For four years past it has been used in regular foundry operation, where a greater tonnage awaits it, but its largest field is in finishing open hearth and especially Bessemer steel for rails, as these have been found unbreakable in service.

The above furnace installation, including the generator, etc., was made by the American Electric Furnace Co., New York, the plate work and rolling portion by the Wellman, Seaver, Morgan Co., Cleveland, O., and the electrical parts by the General Electric Co., Schenectady, N. Y.

Obituary

Professor **George A. Koenig,** who was formerly a member of the University of Pennsylvania faculty, died on Tuesday, January 14, shortly before midnight, at the home of his son, Dr. Augustus Koenig, in Philadelphia. Professor Koenig was the oldest member of the faculty of the Michigan School of Mines, with which he had been connected as Professor of Chemistry since 1892; on January 7 he arrived in Philadelphia with his wife just a few hours before the death of his daughter, Miss Hilda Koenig.

Dr. Koenig is survived by his widow and two children, Dr. Augustus Koenig, a physician and metallurgist, and Mrs. George E. Nitzsche, an artist and portrait painter.

Dr. Koenig was assistant professor of chemistry and mineralogy at the University of Pennsylvania from 1872 to 1879, and professor of mineralogy and geology from 1879 to 1892, and professor of chemistry at the Michigan School of Mines since 1892. At the University of Pennsylvania he gave the first course in mining that was ever given in any educational institution in the United States. He took out a number of valuable patents. In 1897 he invented a new method of assaying without muffle, and later he invented an assay furnace to carry out these methods. In 1881 he patented a method for chlorination of low-grade silver and gold ores, and in 1911 a method of extracting vanadium from ores containing vanadium by which 95% of the vanadium could be recovered. He has prepared artificial crystals of arsenides, of which no natural crystals have ever been found. In 1885 he published his chromometric methods, a development of blow-pipe analysis, and in 1905 an elementary book of chemistry.

Dr. Koenig had a large and valuable collection of minerals which he presented to the Michigan School of Mines. Among the new minerals discovered and named by him are: Hydrotitanite, Randite, Leydyite, Alaskaite, Beegerite, Rementite, Footeite, Paramelaconite, Mezapilite, Mohawkite, Keeweenawite, Stibiodomykite, Melanochalcite. He has also re-examined many other minerals and discovered diamond in meteoric iron.

Professor Koenig was born at Willstatt, Germany, on May 12, 1844. He was educated at the progymnasium at Kork, the School of Moravian Brothers, Lausanne, Switzerland, and a

the Polytechnic School, Karlsruhe, Germany, where he received his degree of Mechanical Engineer. From 1863 to 1865 he was a student at Heidelberg, and from 1865 to 1867 at the University of Berlin, where he received his degrees of Master of Arts and Doctor of Philosophy. Subsequently he attended the Mining Academy at Freiberg, Saxony, for a year.

He came to the United States in October, 1868, and manufactured sodium stannate from tin scraps in Philadelphia. He subsequently became the chief chemist of the Tacony Chemical Works of Philadelphia, and during the winter of 1870 he examined for the Lennig Company several old silver mines in Mexico, traveling much of the distance by stage coach, and enduring many hardships, and having several exciting encounters with the Apache Indians.

Dr. Koenig was held in high esteem, not only for his brilliant scholarship, but for his character and personal worth. He had those genial and magnetic qualities which won for him life-long friendships, not only among thousands of students who came under his charge during the forty years of his career as a professor, but also by his associates and co-workers in scientific fields. He was noted for his fairness and impartiality.

When he left Houghton, only a week before his death, the Houghton *Mining Gazette* printed the following editorial, in which is expressed the sentiment of those with whom he had lived for twenty years:

"The sympathy of the entire community goes out to Dr. and Mrs. Koenig in their bereavement. When the doctor left the other day to find relief and recuperation from his own physical ailments it was with sadness and sorrow that the local public learned that a leave of absence was necessary. And when this wholly unexpected blow, the death of his charming daughter, comes to add to his weight of sorrow the burden seems all the more difficult to carry.

"It is with no feeling of disrespect to the other members of the faculty of the Michigan College of Mines when we say that no man connected with that institution has such a place of love and friendship in the hearts and minds of the graduates and students and townspeople of Houghton as that held by Dr. Koenig.

"Standing high in his rating as a professional man, he stands still higher in the estimate of those qualities of personal charm that make a gentleman known and respected and admired by his fellows.

"We say these few words to let Dr. Koenig know that the sympathy and kindly regard of the whole people is with him in his present bereavement and to express the hope and belief that his wonderful mental strength will give him power to bear up and return to us in the spring renewed in vigor and physical health."

Personal

Mr. Kosaku Asano, metallurgist for the Ashio smelter, Japan, has been visiting American metallurgical works.

Mr. Gelasio Caetani, metallurgical engineer of San Francisco, will deliver a course of lectures at Harvard University in February, after which he expects to go to Europe for a short time.

Mr. A. R. Campbell has been appointed assistant manager of the Dearing, Kan., plant of the American Zinc, Lead & Smelting Company. He was formerly superintendent of the Needles Smelting & Refining Company, Needles, Cal.

Mr. Franz Cazin, metallurgical engineer of Denver, has been engaged in professional work in Mexico.

Mr. F. L. Clerc, of Boulder, Colo., is at Rockport, Texas, where he will stay until about March.

Mr. William Brown Dickson, recently elected president of the International Steam Pump Company, was born in Pittsburgh, Pa., on Nov. 6, 1865, son of John and Mary A. (McConnell) Dickson. He was educated in the public schools of Pittsburgh, Pa., commenced work at an early age and, in 1881, secured employment at the Homestead steel works, which had just been built and placed in operation. After several years passed at manual labor in the mills, he was transferred to the office, acting at first in a clerical capacity, but subsequently received rapid promotion through various grades up to that of assistant to president and managing director of the Carnegie Steel Company. He became a junior partner in the Carnegie Steel Company, Ltd., in 1899. On the formation of the United States Steel Corporation in 1901 he accompanied Mr. C. M. Schwab to New York as assistant to the president of the United States Steel Corporation and later was elected a vice-president of that corporation, which position he held until May 1, 1911, when he resigned in order to retire from active business. Mr. Dickson was elected president of the International Steam Pump Company on Nov. 19, 1912. He succeeded the late Benjamin Guggenheim, who went down on the *Titanic*. Those who are familiar with Mr. Dickson's record in the steel industry do not hesitate to say that the International Steam Pump Company made a wise selection.

Mr. John V. N. Dorr, metallurgical engineer of Denver, spent the month of January in a trip to Central America, taking the West Indian cruise and visiting Panama.

Mr. John Howe Hall, formerly assistant superintendent of the Crucible Steel Department of the Bethlehem Steel Company, South Bethlehem, Pa., and for the last six years metallographist and metallurgist in charge of the research department of what is now the Taylor-Wharton Iron & Steel Company, having completed the installation of metallographic and testing equipment for the latter company, under the direction of Professor Henry F. Howe, vice-president and consulting engineer, and having perfected the operation of this department in investigating, improving, and controlling the quality of the output, has severed his active connection with them (retaining, however, a position as consulting engineer, and has opened an office at 165 Broadway, New York City, to engage in the general practice of consulting metallurgical engineering, making a specialty of steel-making processes, heat treatment and annealing, metallographic and testing equipment for the investigation, improvement and control of product, special steels, etc.

Mr. Charles W. Henderson, of Denver, recently completed an examination of the zinc resources and treatment methods of the Butte district in the interest of the United States Geological Survey.

Dr. Carl Hering, of Philadelphia, Pa., delivered a lecture on January 13 before the engineering students of the University of Virginia, on electrochemistry and electrometallurgy, in the course of which he sketched some of the latest advances in these branches and dwelt on the great possibilities of the future, mentioning many problems awaiting solution.

Mr. L. F. S. Holland, superintendent of the Smuggler-Union Company at Telluride, Colo., has returned to his work after an extended absence in Nova Scotia.

Mr. Milton M. Kohn, well known as the inventor of the replaceable-unit electric furnace, was one of the passengers on the steamship *Turrialba* of the United Fruit Company, which was almost wrecked on Christmas Day. Mr. Kohn, who was returning from a trip to the Panama Canal, is none the worse for the experience.

Mr. C. B. Lakenan, general manager of the Nevada Consolidated Copper Company, was married recently to Mrs. Floribel White, of Los Angeles.

Prof. H. K. Richardson, of the electrochemical department of the Pennsylvania State College, has been chosen by the International Committee of the Y. M. C. A. to take charge of their scientific work in Chengtu, Province of Szechnan, China. The work is both scientific and religious. The scientific work is divded into two parts, one the training of science teachers for the new demand of the educated class of China, the other the taking care of a science museum where working models of inventions that have contributed to the progress of our civilization can be demonstrated.

Mr. Henry E. Wood, of Denver, visited New York City and other Eastern cities in January.

Digest of Electrochemical U. S. Patents

Prior to 1903.

Arranged according to subject-matter and in chronological order.

Compiled by Byrnes, Townsend & Brickenstein, Patent Lawyers, National Union Building, Washington, D. C.

Ore Treatment (*Continued*).

653,538, July 10, 1900, Nathaniel Lewis Turner, of Salmon City, Idaho.

Relates to an apparatus for electrolytically depositing metals from solutions, such as gold-potassium cyanid, from the treatment of slimes, etc., and consists of a tank in which are suspended several concentric anodes, with means to detachably suspend separate cathodes between the anodes. Several rotating stirrers are provided which serve to keep the solution circulating. The anodes may be of iron or copper, and are covered with canvas; the cathodes are of lead or copper, and may also be covered with canvas. Provision is made for the examination and replacement of cathodes during the electrodeposition.

654,437, July 24, 1900, William Arthur Caldecott, of Johannesburg, South African Republic.

Relates to a method of precipitating gold from their cyanid solutions. Consists in passing the cyanid solution through precipitating boxes filled with mechanical mixtures of zinc shavings and lead shavings, as distinguished from zinc-lead couples, and shavings of zinc-lead alloys. The shavings are made by winding layers of zinc and lead, separated by paper, on a mandrel, forming a compact cylinder, and making the shavings as usual. The zinc and lead together form an electric couple, the paper forming a separator between them. It is stated that the mechanical mixture of shavings retains its efficiency longer than other forms of shavings.

656,305, August 21, 1900, Wilhelm Strzoda, of Falenze, Germany.

Relates to the solution of zinc compounds and ores in alkaline solutions, and the deposition of the zinc from the solution. Within a metal-lined tank are suspended anodes and cathodes, the metal lining also being connected as a cathode. Zinc ore or waste products are placed on the bottom, and an alkaline solution added to the tank. The solution may contain caustic soda, potash, ammonia, or any ammoniacal salt, either alone or with the addition of a salt of sodium, or of potassium, or the like. The continual evolution of hydrogen from the bottom of the tank keeps the ore, etc., stirred up in the solution. With sodium hydrate the soluble zinc compounds form sodium zincate, which is decomposed by the current depositing metallic zinc and reforming sodium hydrate. Other metals present, such as gold, silver, lead, tin, and cadmium, will be reduced to the metallic state, and if their compounds are also soluble, the metal will be deposited on the cathode with the zinc. The deposited metals may be separated in any usual manner. The solution can be separated from the residue by a filter-press and re-used.

657,032, August 28, 1900, Albion M. Rouse, of Denver, Colorado, assignor of one-half to William G. Shedd and Frank Brooks, of same place.

Relates to apparatus for dissolving the metallic values in ores, and for electroplating the dissolved metal. It consists of a tank in which ore is placed, and containing a central tube communicating with the outer space through perforations at the bottom. Within the tube, and just above the perforations is a rotary stirrer, or propeller which serves to pump the mixed solution and finely-divided ore pulp up through the central tube and down through the outer tank, causing continuous agitation and circulation of the pulp. By means of an anode and cathode located on opposite sides of the outer tank the dissolved metal is separated from the solution.

662,286, November 20, 1900, Emanuel Motz, of Jefferson, South Carolina.

Relates to an apparatus for electroamalgamating and electrodissolving and depositing metal from ores and solutions. It consists of a plurality of sections of a flume, connected so as to constitute a continuous channel for a flow of pulp and solution. On the bottom of each section, transversely to the flume, is a cathode plate of copper amalgamated, and parallel thereto and above it is an anode of lead suitably supported. Between two adjacent anodes is a vertically adjustable amalgamated metallic cathode plate the width of the flume, and which serves to agitate the pulp in the solution as the latter passes beneath the plate. The several sections are arranged in cascade so as to afford a continuous flow to the pulp. During the operation, any free gold is caught on the amalgamated cathode plates; the finely-divided gold will be dissolved by the solution with the aid of electrolysis and the dissolved gold redeposited on the amalgamated cathodes.

664,269, December 18, 1900, Carl Hoepfner, of Frankfort-on-the-Main, Germany.

Relates to a process of recovering zinc from ores and other materials. The zinc should be as carbonate or oxid, and is digested while under pressure and above normal temperature, with a concentrated solution of calcium chlorid and with carbon dioxid; or a mixture of this gas and air with zinc carbonate. The reactions are as follows:

$$ZnCO_3 + CaCl_2 = ZnCl_2 + CaCO_3.$$

The solution of zinc chlorid may then be enriched, if desired, and then electrolyzed. Any zinc chlorid remaining in the electrolyte is precipitated with hydrated lime. In the extraction of zinc from calamine (native carbonate) or roasted blende in contact with the carbon dioxid, or artificial zinc carbonate, solutions of calcium chlorid, solutions obtained in the ammonia-soda process, chlorate of potash, etc., may be used, or solutions of carnallite to which hydrated lime is added, may be used; the potassium chlorid in the carnallite may be used in the manufacture of chlorate of potash. The process is preferably carried out in a steam-jacketed digester containing a rotating stirrer.

664,537, Dec. 25, 1900, James Douglas, of New York, N. Y.

Relates to the extraction of copper from copper ore and matte by the chlorin or chlorin compounds resulting from the electrolysis of cuprous chlorid, and refers to his earlier patent No. 563,144. Broken pieces of ore or matte are placed in a suitable column, such as earthenware tubes, and the chlorin or gaseous chlorin compounds from the electrolysis of cuprous chlorid is passed through the ore or matte. The copper in the ore combines with the chlorin or chlorin compounds to form cupric and cuprous chlorids. If the acid electrolyte resulting from the electrolysis of the cuprous chlorid is used to leach the ore, the solution obtained is run back into the electrolytic vat.

668,842, Feb. 26, 1901, Albion M. Rouse, of Denver, Colorado, assignor of one-half to William G. Shedd and Frank Brooks, of same place.

Appears to be an improvement on his earlier patent No. 657,032, and relates to an apparatus for recovering gold and silver from ores. It consists of a plurality of tubs, having conical bottoms, with a valve and conduit connections to a vertical tube in which is a rotary stirrer to circulate the ore upwards through the tube and into the tubs through distributors. The ore is reduced to a fine pulp and mixed with about an equal weight of water, to which is added the solvent chemical, such as potassium cyanid, and supplied to the tubs, its temperature being maintained at from 90 deg. F. to 120 deg. F. by a steam pipe running through the tub. The pulp flows through a valve at the bottom of the tub, into a conduit leading to the upright tube, thence to the distributor consisting of a channel along the interior wall at the upper edge of the tub; the underpart of the channel being perforated, and provided with inclined chutes which give the pulp a swirling motion as it runs into the tub. This swirling motion of the ore causes the particles to rub against and clean each other, as well as thoroughly mix the ore and solvent. Anodes and cathodes are suspended in the circulating pulp, the dissolved metals being electrodeposited; the deposit of one operation serving as the cathode in a succeeding operation.